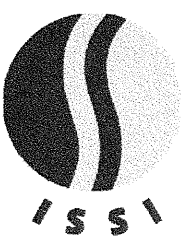
BIOAVAILABILITY OF LEAD IN UNWEATHERED GALENA-ENRICHED SOIL

June 1998

PHASE II SWINE BIOAVAILABILITY INVESTIGATIONS



BIOAVAILABILITY OF LEAD IN UNWEATHERED GALENA-ENRICHED SOIL

June 1998

Stan W. Casteel, DVM, PhD, DABVT
Principal Investigator
Larry D. Brown, DVM, MPH
Margaret E. Dunsmore, BS
Co-Investigators
Veterinary Medical Diagnostic Laboratory
College of Veterinary Medicine
University of Missouri, Columbia
Columbia, Missouri

Christopher P. Weis, PhD, DABT
Gerry M. Henningsen, DVM, PhD, DABT/DABVT
Eva Hoffman, PhD
Study Design and Technical Advisors
US Environmental Protection Agency
Region VIII
Denver, Colorado

William J. Brattin, PhD
Tracy L. Hammon, MS
Technical Consultants
ISSI Consulting Group, Inc.
Denver, Colorado

Document Control Number 04800-030-0171

ACKNOWLEDGEMENTS

The work described in this report is the product of a team effort involving a number of people. In particular, the authors would like to acknowledge the efforts and support of the following:

Dr. John Drexler at the University of Colorado, Boulder, performed the electron microprobe and particle size analyses of the test materials.

Dr. Dan Paschal at the Centers for Disease Control and Prevention (CDCP) provided samples of blood for use as internal quality control samples, and also performed independent preparation and analyses of blood lead samples from the study for interlaboratory comparisons.

Mr. Stan Christensen of the USEPA has provided oversight and quality assurance support regarding many aspects of the analytical phases of this study.

Tamarac Medical performed the analyses of all of the samples generated during this study, including blood, liver, kidney, bone, feed, water, and miscellaneous other materials.

Mr. Gerald Almquist at Roy F. Weston provided overall program management for the project, including management of subcontractors and coordination of interactions between team members.

Ross P. Cowart, DVM, MS, DACVIM, University of Missouri, Columbia, provided expert evaluation of the health of the animals on study

James R. Turk, DVM, PhD, DACVP, University of Missouri, Columbia, performed necropsy and pathological examination of all animals

John T. Payne, DVM, MS, DACVS, University of Missouri, Columbia, performed the surgery to implant intravenous catheters and vascular access ports

Steven L. Stockham, DVM, MS, DACVP, University of Missouri, Columbia, assessed clinical pathology data.

EXECUTIVE SUMMARY

A study using young swine as test animals was performed to measure the gastrointestinal absorption of lead from a sample of galena (lead sulfide) mixed with soil. Young swine were selected for use in the study primarily because the gastrointestinal physiology and overall size of young swine are similar to that of young children, who are the population of prime concern for exposure to lead.

The test sample was prepared by grinding a mineralogic (i.e., native) crystal of galena, sieving the ground material to obtain particles smaller than about 65 um, and mixing the sieved particles with a low-lead soil (< 50 ppm). The resulting concentration of lead in the galena/soil mixture was 11,200 mg/kg. Groups of 5 swine were given repeated oral doses of the galena/soil test material (75, 225 or 675 ug Pb/kg-day) or lead acetate (25, 75, or 225 ug Pb/kg-day) for 15 days. Another group of animals served as the control. The amount of lead absorbed by each animal was evaluated by measuring the amount of lead in the blood (measured on days -4, 0, 1, 2, 3, 5, 7, 9, 12, and 15), and the amount of lead in liver, kidney and bone (measured on day 15 at study termination). The amount of lead present in blood or tissues of animals exposed to the galena test material was compared to that for animals exposed to lead acetate, and the results were expressed as relative bioavailability (RBA). For example, a relative bioavailability of 50% means that 50% of the lead in test material was absorbed equally as well as lead from lead acetate, and 50% behaved as if it were not available for absorption. Thus, if lead acetate were 40% absorbed, the test material would be 20% absorbed.

The RBA results for the galena/soil sample are summarized below:

Measurement Endpoint	Estimated RBA for Galena
Blood Lead AUC	0.01
Liver Lead	0.00
Kidney Lead	0.01
Bone Lead	0.01

As seen, the estimated RBA for galena is very low (probably 1% or less). If a soil-galena mixture were ingested by a child, the RBA estimates above could be used to estimate the absolute bioavailability (ABA) of lead in the material, as follows:

$$ABA_{galena} = ABA_{soluble} \cdot RBA_{galena}$$

Available data indicate that fully soluble forms of lead are about 50% absorbed by a child. Thus, the estimated absolute bioavailability of lead in a galena/soil mixture would be about 0.5% or less.

This absolute bioavailability estimate could be used in EPA's IEUBK model to assess the risks to a child from ingestion of a soil/galena mixture similar to the one tested here. However, it is clear that there is both natural variability and uncertainty associated with these estimates. This variability and uncertainty arises from several sources, including : 1) the inherent variability in the responses of different individual animals to lead exposure, 2) the extrapolation of measured RBA values in swine to young children, and 3) uncertainty whether the soil/galena sample used in this study is representative of all galena particles in soil and waste rock from mining sites. However, despite these uncertainties, it seems clear that the absorption of lead from galena particles by children is likely to be very low.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

BIOAVAILABILITY OF LEAD IN GALENA

1.0 INTRODUCTION

Absolute and Relative Bioavailability

Bioavailability is a concept that relates to the absorption of chemicals and how absorption depends upon the physical-chemical properties of the chemical and its medium (e.g., dust, soil, rock, food, water, etc.) and the physiology of the exposed receptor. Bioavailability is normally described as the fraction (or percentage) of a chemical which enters into the blood following an exposure of some specified amount, duration and route (usually oral). In some cases, bioavailability may be measured using chemical levels in peripheral tissues such as liver, kidney, and bone, rather than blood. The fraction or percentage absorbed may be expressed either in absolute terms (absolute bioavailability, ABA) or in relative terms (relative bioavailability, RBA). **Absolute bioavailability** is measured by comparing the amount of chemical entering the blood (or other tissue) following oral exposure to test material with the amount entering the blood (or other tissue) following intravenous exposure to an equal amount of some dissolved form of the chemical. Similarly, **relative bioavailability** is measured by comparing oral absorption of test material to oral absorption of some fully soluble form of the chemical (e.g., either the chemical dissolved in water, or a solid form that is expected to fully dissolve in the stomach). For example, if 100 ug of dissolved lead were administered in drinking water and a total of 50 ug entered the blood, the ABA would be 0.50 (50%). Likewise, if 100 ug of lead in soil were administered and 30 ug entered the blood, the ABA for soil would be 0.30 (30%). If the lead dissolved in water were used as the reference substance for describing the relative amount of lead absorbed from soil, the RBA would be 0.30/0.50 = 0.60 (60%). These values (50% absolute bioavailability of dissolved lead and 30% absolute absorption of lead in soil) are the values currently employed as defaults in EPA's IEUBK model.

It is important to recognize that simple solubility of a test material in water or some other fluid (e.g., a weak acid intended to mimic the gastric contents of a child) may not be a reliable estimator of bioavailability due to the non-equilibrium nature of the dissolution and transport processes that occur in the gastrointestinal tract (Mushak 1991). For example, transport of lead across the gut may continuously shift the equilibrium of a poorly soluble lead compound in the direction of dissolution. However, information on the solubility of lead in different materials is useful in interpreting the importance of solubility as a determinant of bioavailability. To avoid confusion, the term "bioaccessability" is used to refer to the relative amount of lead that dissolves under a specified set of test conditions.

For additional discussion about the concept and application of bioavailability see Goodman et al. (1990), Klaassen et al. (1996), and/or Gibaldi and Perrier (1982).

Using Bioavailability Data to Improve Exposure Calculations for Lead

Data on bioavailability are important for evaluating exposure and potential health effects for a variety of different types of chemicals. Overall, the current project has focused mainly on evaluating the bioavailability of lead in various samples of soil or other solid materials from mining, milling or smelting sites. This is because lead may exist, at least in part, as poorly water soluble minerals, and may also exist inside particles of inert matrix such as rock or slag of variable size, shape and association. The chemical and physical properties of lead in different types of mineral forms may be important determinants of the solubility (bioaccessability) and the absorption (bioavailability) of lead when ingested.

When data are available on the bioavailability of lead in soil, dust, or other soil-like waste material at a site, this information can often be used to improve the accuracy of exposure and risk calculations at that site. The basic equation for estimating the site-specific ABA of a test soil is as follows:

$$ABA_{soil} = ABA_{soluble} \cdot RBA_{soil}$$

where:

ABA_{soil} = Absolute bioavailability of lead in soil ingested by a child
$ABA_{soluble}$ = Absolute bioavailability in children of some dissolved or fully soluble form of lead
RBA_{soil} = RBA for soil measured in swine

Based on available information on lead absorption in humans and animals, the EPA estimates that the absolute bioavailability of lead from water and other fully soluble forms of lead is usually about 50% in children. Thus, when a reliable site-specific RBA value for soil is available, it may be used to estimate a site-specific absolute bioavailability as follows:

$$ABA_{soil} = 50\% \cdot RBA_{soil}$$

In the absence of site-specific data, the absolute absorption of lead from soil, dust and other similar media is estimated by EPA to be about 30%. Thus, the default RBA used by EPA for lead in soil and dust compared to lead in water is 30%/50% = 60%. When the measured RBA in soil or dust at a site is found to be less than 60% compared to some fully soluble form of lead, it may be concluded that exposures to and risks from lead in these media at that site are probably lower than typical default assumptions. If the measured RBA is higher than 60%, absorption of and risk from lead in these media may be higher than usually assumed.

This study focused on a sample of test material prepared by mixing small particles of galena (lead sulfide) with soil which was otherwise very low in lead (< 50 ppm). The purpose of the investigation was to derive data that would allow calculation of the RBA for galena particles in soil.

2.0 STUDY DESIGN

A standardized study protocol for measuring absolute and relative bioavailability of lead was developed based upon previous study designs and investigations that characterized the young pig model (Weis et al. 1995). The study was performed as nearly as possible within the spirit and guidelines of Good Laboratory Practices (GLP: 40 CFR 792). Standard Operating Procedures (SOPs) that included detailed methods for all aspects of the study were prepared, approved, and distributed to all study members prior to the study. The generalized study design, quality assurance project plan and all standard operating procedures are documented in a project notebook that is available through the administrative record.

2.1 Test Material

The test material used in this study was prepared by grinding a mineralogical (i.e., native) crystal of pure galena and sieving to obtain fine particles smaller than about 65 um. This was done because it is believed that fine particles are most likely to adhere to the hands of children and be ingested by hand-to-mouth contact, and are also most likely to be available for absorption.

To prepare the test material, approximately 6 grams of the ground and sieved galena were mixed with approximately 500 grams of a low lead soil (< 50 ppm) that was collected in Leadville, Colorado. The resulting final concentration of lead in the soil/galena mixture measured by CLP analysis was 11,200 ppm. Table 2-1 shows the full CLP analysis of the soil/galena mixture.

The soil/galena mixture was also analyzed by electron microprobe in order to characterize the chemical nature of the lead in the mixture. As expected, essentially 100% of the lead existed as liberated particles of galena. Figure 2-1 shows the observed particle size distribution for the galena particles. As seen, approximately half of the particles are very small (less than 5 um), with the remainder ranging from about 5-60 um in diameter.

2.2 Experimental Animals

Young swine were selected for use in these studies because they are considered to be a good physiological model for gastrointestinal absorption in children (Weis and LaVelle 1991). The animals were intact males of the Pig Improvement Corporation (PIC) genetically defined Line 26, and were purchased from Chinn Farms, Clarence, MO. The animals were held under quarantine to observe their health for one week before beginning exposure to the test material. To minimize weight variations between animals and groups, the number of animals purchased from the supplier was six more than needed for the study, and the six animals most different in body weight on day -4 (either heavier or lighter) were excluded from further study. The remaining animals were assigned to dose groups at random. When exposure began, the animals were about 5-6 weeks old (juveniles, weaned at 3 weeks) and weighed an average of about 8.1 kg. Animals were weighed every three days during the course of the study. The group mean body weights over the course of the study are shown in Figure 2-2. As seen, on average,

TABLE 2-1 METAL ANALYSIS OF GALENA-ENRICHED SOIL

Chemical	Concentration (ppm)
Aluminum	6,340
Antimony	8.7
Arsenic	4.9
Barium	112
Beryllium	0.5
Cadmium	0.8
Calcium	2650
Chromium	10.2
Cobalt	3.1
Copper	11.1
Iron	10,000
Lead	**11,200**
Magnesium	2,790
Manganese	293
Mercury	0.06
Nickel	3.8
Potassium	1,460
Selenium	0.61
Silver	0.63
Sodium	31.2
Thallium	0.87
Vanadium	12.6
Zinc	107

FIGURE 2-1 PARTICLE SIZE DISTRIBUTION FOR GALENA ENRICHED SOIL

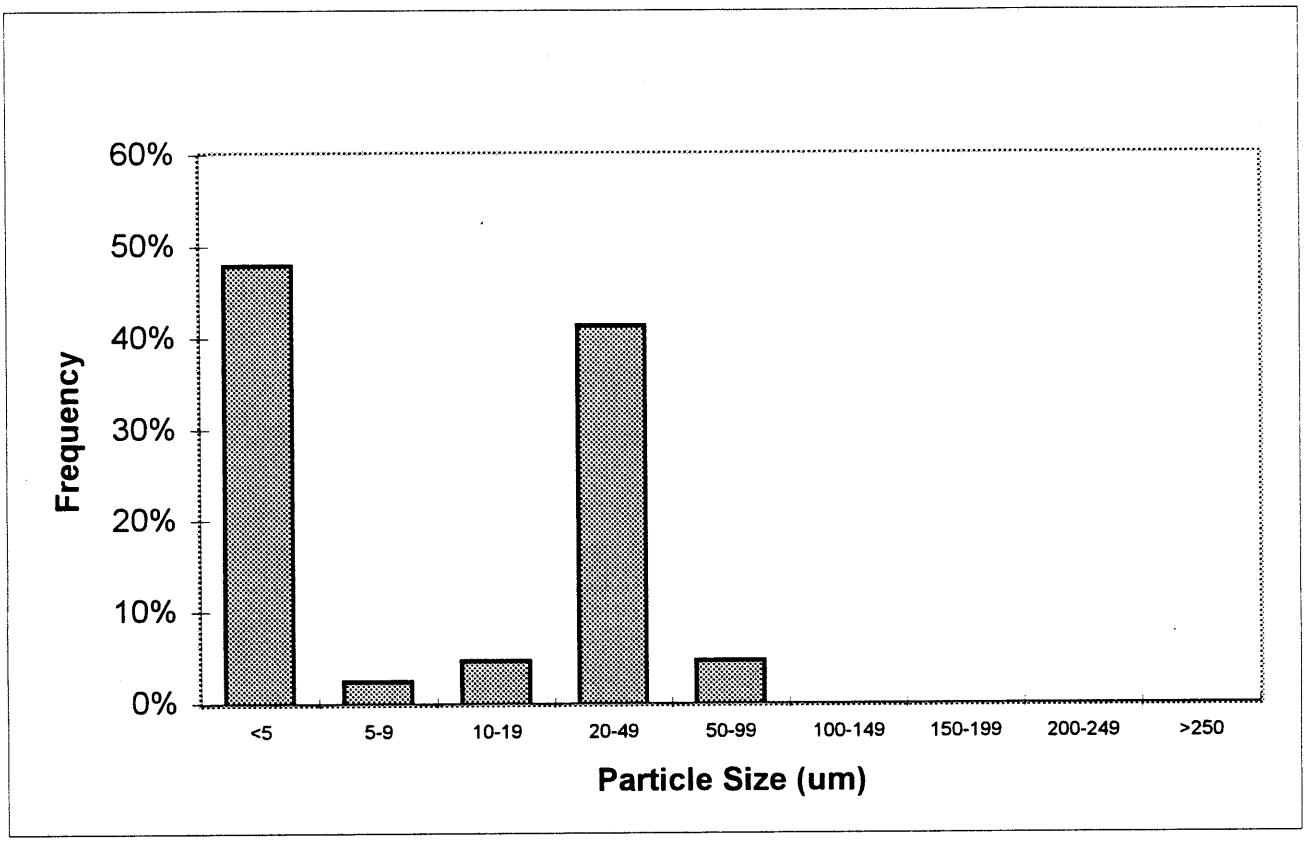
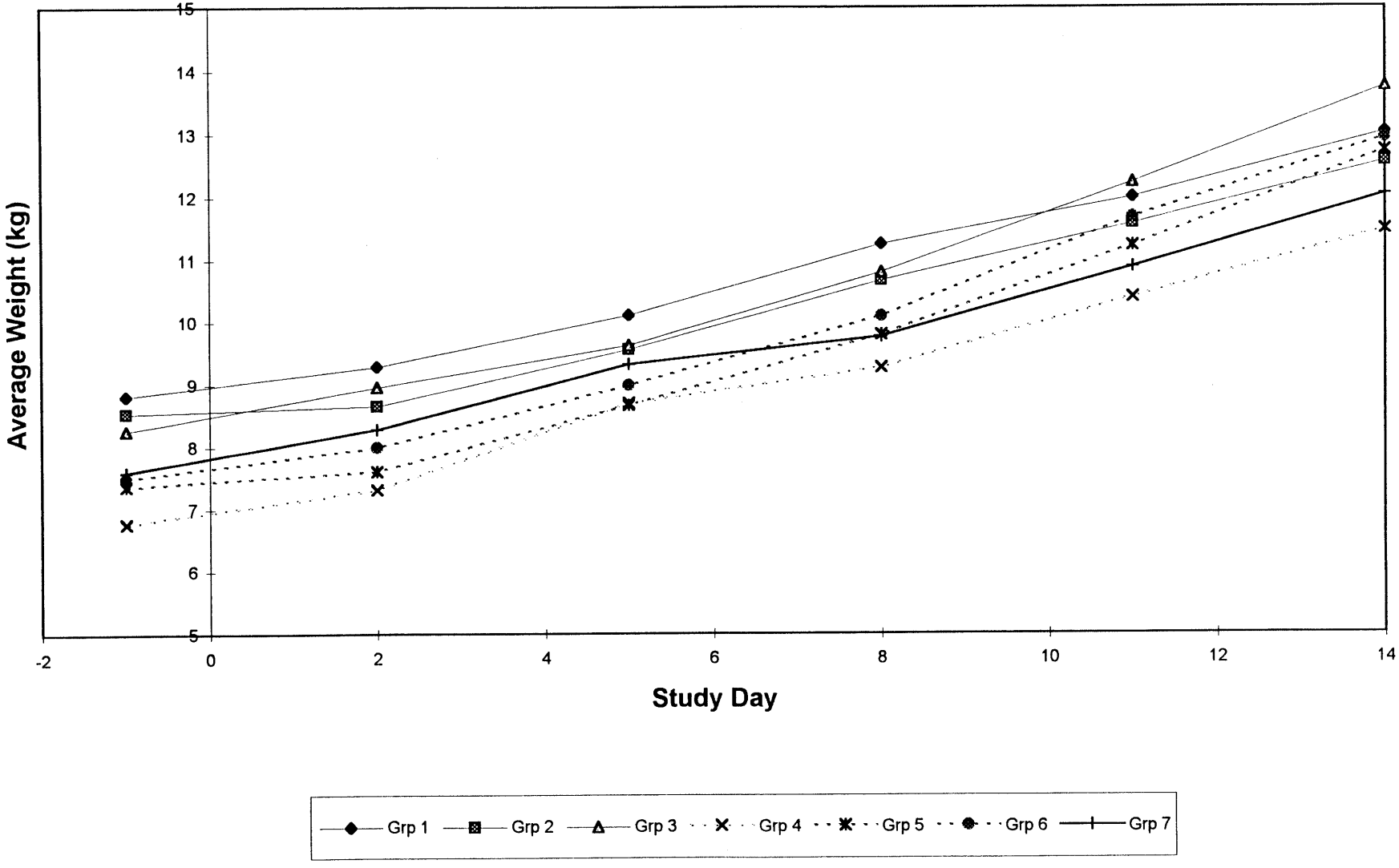


FIGURE 2-2 BODY WEIGHTS OF TEST ANIMALS
PHASE II EXPERIMENT 12



animals gained about 0.3 kg/day, and the rate of weight gain was comparable in all groups.

All animals were housed in individual lead-free stainless steel cages. Each animal was examined by a certified veterinary clinician (swine specialist) prior to being placed on study, and all animals were examined daily by an attending veterinarian while on study. Any animal that displayed significant signs of illness was given appropriate treatment, and was removed from study if the illness could not be promptly controlled. Blood samples were collected for hematological analysis on days -4, 7, and 15 to assist in clinical health assessments. In this study, there were no animals that were judged by the principle investigator and the veterinary clinician to be seriously ill, and no animals were removed from the study.

2.3 Diet

Animals provided by the supplier were weaned onto standard pig chow purchased from MFA Inc., Columbia, MO. In order to minimize lead exposure from the diet, the animals were gradually transitioned from the MFA feed to a special low-lead feed (guaranteed less than 0.2 ppm lead, purchased from Zeigler Brothers, Inc., Gardners, PA) over the time interval from day -7 to day -3, and this feed was then maintained for the duration of the study. The feed was nutritionally complete and met all requirements of the National Institutes of Health-National Research Council. The typical nutritional components and chemical analysis of the feed are presented in Table 2-2. Typically, the feed contained approximately 5.7% moisture, 1.7% fiber, and provided about 3.4 kcal of metabolizable energy per gram. Periodic analysis of feed samples during this program indicated the mean lead level (treating non-detects at one-half the quantitation limit of 0.05 ppm) was less than 0.05 ppm.

Each day every animal was given an amount of feed equal to 5% of the mean body weight of all animals on study. Feed was administered in two equal portions of 2.5% of the mean body weight at each feeding. Feed was provided at 11:00 AM and 5:00 PM daily. Drinking water was provided ad libitum via self-activated watering nozzles within each cage. Periodic analysis of samples from randomly selected drinking water nozzles indicated the mean lead concentration (treating non-detects at one-half the quantitation limit) was less than 2 ug/L.

2.4 Dosing

The protocol for exposing animals to lead is shown in Table 2-3. Animals were exposed to lead for 15 days, with the dose for each day being administered in two equal portions given at 9:00 AM and 3:00 PM (two hours before feeding). Doses were based on measured group mean body weights, and were adjusted every three days to account for animal growth. For animals exposed by the oral route, dose material was placed in the center of a small portion (about 5 grams) of moistened feed, and this was administered to the animals by hand. Most animals consumed the dose promptly, but occasionally some animals delayed ingestion of the dose for up to two hours (the time the daily feed portion was provided). These delays are noted in the data provided in Appendix A, but are not considered to be a significant source of error. Occasionally, some animals did not consume some or all of the dose (usually because the dose dropped from their

TABLE 2-2 TYPICAL FEED COMPOSITION[a]

Nutrient Name	Amount	Nutrient Name	Amount
Protein	20.1021%	Chlorine	0.1911%
Arginine	1.2070%	Magnesium	0.0533%
Lysine	1.4690%	Sulfur	0.0339%
Methionine	0.8370%	Manganese	20.4719 ppm
Met+Cys	0.5876%	Zinc	118.0608 ppm
Tryptophan	0.2770%	Iron	135.3710 ppm
Histidine	0.5580%	Copper	8.1062 ppm
Leucine	1.8160%	Cobalt	0.0110 ppm
Isoleucine	1.1310%	Iodine	0.2075 ppm
Phenylalanine	1.1050%	Selenium	0.3196 ppm
Phe+Tyr	2.0500%	Nitrogen Free Extract	60.2340%
Threonine	0.8200%	Vitamin A	5.1892 kIU/kg
Valine	1.1910%	Vitamin D3	0.6486 kIU/kg
Fat	4.4440%	Vitamin E	87.2080 IU/kg
Saturated Fat	0.5590%	Vitamin K	0.9089 ppm
Unsaturated Fat	3.7410%	Thiamine	9.1681 ppm
Linoleic 18:2:6	1.9350%	Riboflavin	10.2290 ppm
Linoleic 18:3:3	0.0430%	Niacin	30.1147 ppm
Crude Fiber	3.8035%	Pantothenic Acid	19.1250 ppm
Ash	4.3347%	Choline	1019.8600 ppm
Calcium	0.8675%	Pyridoxine	8.2302 ppm
Phos Total	0.7736%	Folacin	2.0476 ppm
Available Phosphorous	0.7005%	Biotin	0.2038 ppm
Sodium	0.2448%	Vitamin B12	23.4416 ppm
Potassium	0.3733%		

[a] Nutritional values provided by Zeigler Bros., Inc.

TABLE 2-3 DOSING PROTOCOL

Group[a]	Number of Animals	Dose Material Administered	Exposure Route	Lead Dose (ug Pb/kg-d)	
				Target	Actual[b]
1	3	None	Oral	0	0
2	5	Lead acetate	Oral	25	27.3
3	5	Lead acetate	Oral	75	78.0
4	5	Lead acetate	Oral	225	239
5	5	Galena/Soil	Oral	75	78.8
6	5	Galena/Soil	Oral	225	234
7	8	Galena/Soil	Oral	675	715

Doses were administered in two equal portions given at 9:00 AM and 3:00 PM each day. Doses were based on the mean weight of the animals in each group, and were adjusted every three days to account for weight gain.

[a] Groups 8-11 not shown; data are for a different test material

[b] Calculated as the administered daily dose divided by the measured or extrapolated daily body weight, averaged over days 0-14 for each animal and each group.

mouth while chewing). All missed doses were recorded and the time-weighted average dose calculation for each animal was adjusted downward accordingly.

Actual mean doses, calculated from the administered doses and the measured body weights, are also shown in Table 2-3.

2.5 Collection of Biological Samples

Blood

Samples of blood were collected from each animal four days before exposure began (day -4), on the first day of exposure (day 0), and on days 1, 2, 3, 5, 7, 9, 12, and 15 following the start of exposure. All blood samples were collected by vena-puncture of the anterior vena cava, and samples were immediately placed in purple-top Vacutainer® tubes containing EDTA as anticoagulant. Blood samples were collected each sampling day beginning at 8:00 AM, approximately one hour before the first of the two daily exposures to lead on the sampling day and 17 hours after the last lead exposure the previous day. This blood collection time was selected because the rate of change in blood lead resulting from the preceding exposures is expected to be relatively small after this interval (LaVelle et al. 1991, Weis et al. 1993), so the exact timing of sample collection relative to last dosing is not likely to be critical.

Following collection of the final blood sample at 8:00 AM on day 15, all animals were humanely euthanized and samples of liver, kidney, and bone (the right femur) were removed and stored in lead-free plastic bags for lead analysis. Samples of all biological samples collected were archived in order to allow for later reanalysis and verification, if needed. All animals were also subjected to detailed examination at necropsy by a certified veterinary pathologist in order to assess overall animal health.

2.6 Preparation of Biological Samples for Analysis

Blood

One mL of whole blood was removed from the purple-top Vacutainer and added to 9.0 mL of "matrix modifier", a solution recommended by the Centers for Disease Control and Prevention (CDCP) for analysis of blood samples for lead. The composition of matrix modifier is 0.2% (v/v) ultrapure nitric acid, 0.5% (v/v) Triton X-100, and 0.2% (w/v) dibasic ammonium phosphate in deionized and ultrafiltered water. Samples of the matrix modifier were routinely analyzed for lead to ensure the absence of lead contamination.

Liver and Kidney

One gram of soft tissue (liver or kidney) was placed in a lead-free screw-cap teflon container with 2 mL of concentrated (70%) nitric acid and heated in an oven to 90°C overnight. After

cooling, the digestate was transferred to a clean lead-free 10 mL volumetric flask and diluted to volume with deionized and ultrafiltered water.

Bone

The right femur of each animal was removed and defleshed, and dried at 100°C overnight. The dried bones were then placed in a muffle furnace and dry-ashed at 450°C for 48 hours. Following dry ashing, the bone was ground to a fine powder using a lead-free mortar and pestle, and 200 mg was removed and dissolved in 10.0 mL of 1:1 (v:v) concentrated nitric acid:water. After the powdered bone was dissolved and mixed, 1.0 mL of the acid solution was removed and diluted to 10.0 mL by addition of 0.1% (m/v) lanthanum oxide (La_2O_3) in deionized and ultrafiltered water.

2.7 Lead Analysis

Samples of biological tissue (blood, liver, kidney, bone) and other materials (food, water, reagents and solutions, etc.) were arranged in a random sequence and provided to EPA's analytical laboratory in a blind fashion (identified to the laboratory only by a chain of custody tag number). Each sample was analyzed for lead using a Perkin Elmer Model 5100 graphite furnace atomic absorption spectrophotometer. Internal quality assurance samples were run every tenth sample, and the instrument was recalibrated every 15th sample. A blank, duplicate and spiked sample were run every 20th sample.

All results from the analytical laboratory were reported in units of ug Pb/L of prepared sample. The quantitation limit was defined as three-times the standard deviation of a set of seven replicates of a low-lead sample (typically about 2-5 ug/L). The standard deviation was usually about 0.3 ug/L, so the quantitation limit was usually about 0.9-1.0 ug/L (ppb). For prepared blood samples (diluted 1/10), this corresponds to a quantitation limit of 10 ug/L (1 ug/dL). For soft tissues (liver and kidney, diluted 1/10), this corresponds to a quantitation limit of 10 ug/kg (ppb) wet weight, and for bone (final dilution = 1/500) the corresponding quantitation limit is 0.5 ug/g (ppm) ashed weight.

3.0 DATA ANALYSIS

3.1 Overview

Studies on the absorption of lead are often complicated because some biological responses to lead exposure may be non-linear functions of dose (i.e., tending to flatten out or plateau as dose increases). The cause of this non-linearity is uncertain but might be due either to non-linear **absorption kinetics** and/or to non-linear **biological response** per unit dose absorbed. When the dose-response curve for either the reference material (lead acetate) and/or the test material is non-linear, RBA is equal to the ratio of doses that produce equal responses (not the ratio of responses at equal doses). This is based on the simple but biologically plausible assumption that equal absorbed doses yield equal biological responses. Applying this assumption leads to the following general methods for calculating RBA from a set of non-linear experimental data:

1. Plot the biological responses for individual animals exposed to a series of oral doses of soluble lead (e.g., lead acetate). Find an equation which gives a smooth best fit line through the observed data.

2. Plot the biological response for individual animals exposed to a series of doses of test material. Find an equation which gives a smooth fit line through the observed data.

3. Using the best fit equations for reference material and test material, calculate RBA as the ratios of doses of test material and reference material which yield equal biological responses. Depending on the relative shape of the best-fit lines through the lead acetate and test material dose response curves, RBA may either be constant (dose-independent) or variable (dose-dependent).

The principal advantage of this approach is that it is not necessary to understand the basis for a non-linear dose response curve (non-linear absorption and/or non-linear biological response) in order to derive valid RBA estimates. Also, it is important to realize that this method is very general, as it will yield correct results even if one or both of the dose-response curves are linear. In the case where both curves are linear, RBA is dose-independent and is simply equal to the ratio of the slopes of the best-fit linear equations.

3.2 Fitting the Curves

There are a number of different mathematical equations which can yield reasonable fits with the dose-response data sets obtained in this study. In selecting which equations to employ, the following principles were applied: 1) mathematically simple equations were preferred over mathematically complex equations, 2) the shape of the curves had to be smooth and biologically realistic, without inflection points, maxima or minima, and 3) the general form of the equations had to be able to fit data not only from this one study, but from all the studies that are part of

this project. After testing a wide variety of different equations, it was found that all data sets could be well fitted using one of the following three forms:

Linear (LIN): $\text{Response} = a + b \cdot \text{Dose}$

Exponential (EXP): $\text{Response} = a + c \cdot (1\text{-}\exp(-d \cdot \text{Dose}))$

Combination (LIN+EXP): $\text{Response} = a + b \cdot \text{Dose} + c \cdot (1\text{-}\exp(-d \cdot \text{Dose}))$

Although underlying mechanism was not considered in selecting these equations, the linear equation allows fitting data that do not show evidence of saturation in either uptake or response, while the exponential and mixed equations allow evaluation of data that appear to reflect some degree of saturation in uptake and/or response.

Each dose-response data set was fit to each of the equations above. If one equation yielded a fit that was clearly superior (as judged by the value of the adjusted correlation coefficient R^2) to the others, that equation was selected. If two or more models fit the data approximately equally well, then the simplest model (that with the fewest parameters) was selected. In the process of finding the best-fits of these equations to the data, the values of the parameters (a, b, c, and d) were subjected to some constraints, and some data points (those that were outside the 95% prediction limits of the fit) were excluded. These constraints and outlier exclusion steps are detailed in Appendix A (Section 3). In general, most blood lead AUC dose-response curves were best fit by the exponential equation, and most dose-response curves for liver, kidney, and bone were best fit by linear equations.

3.3 Responses Below Quantitation Limit

In some cases, most or all of the responses in a group of animals were below the quantitation limit for the endpoint being measured. For example, this was normally the case for blood lead values in unexposed animals (both on day -4 and day 0, and in control animals), and also occurred during the early days in the study for animals given test materials with low bioavailability. In these cases, all animals which yielded responses below the quantitation limit were evaluated as if they had responded at one-half the quantitation limit.

3.4 Quality Assurance

A number of steps were taken throughout this study and the other studies in this project to ensure the quality of the results. These steps are summarized below.

Duplicates

A randomly selected set of about 5% of all samples generated during the study were submitted to the laboratory in a blind fashion for duplicate analysis. The raw data are presented in

Appendix A, and Figure 3-1 plots the results for blood (Panel A, upper) and for bone, liver and kidney (Panel B, lower). As seen, there was good intra-laboratory reproduciblity between duplicate samples for both blood and tissues, with linear regression lines having a slope near 1.0, an intercept near zero, and an R^2 value very near 1.00.

Standards

The Centers for Disease Control and Prevention (CDCP) provide a variety of blood lead "check samples" for use in quality assurance programs for blood lead studies. Each time a group of blood samples was prepared and sent to the laboratory for analysis, several CDCP check samples of different concentrations were included in random order and in a blind fashion.

The results for the samples submitted during this study are presented in Appendix A, and the values are plotted in Figure 3-2 (Panel A, upper). As seen, the analytical results obtained for the check samples were generally good at all three concentrations, with mean results of 1.4 ug/L for the low standards (nominal = 1.7 ug/L), 4.6 ug/L for the middle standard (nominal = 4.8 ug/L), and 15.5 ug/L for the high standards (nominal = 14.9 ug/L).

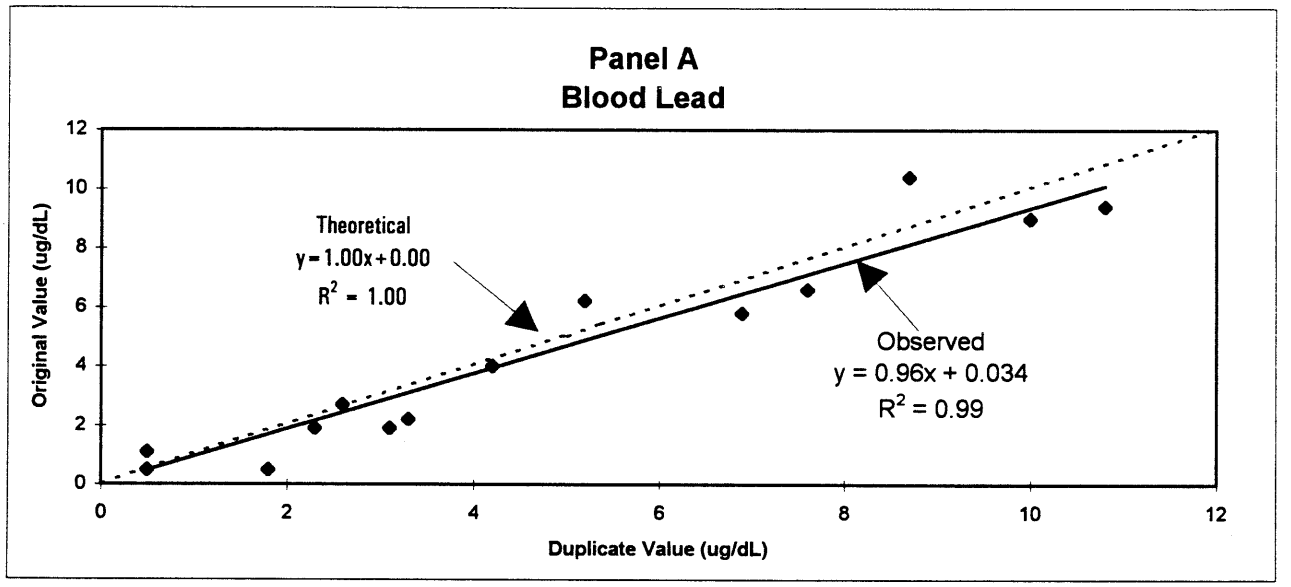
Interlaboratory Comparison

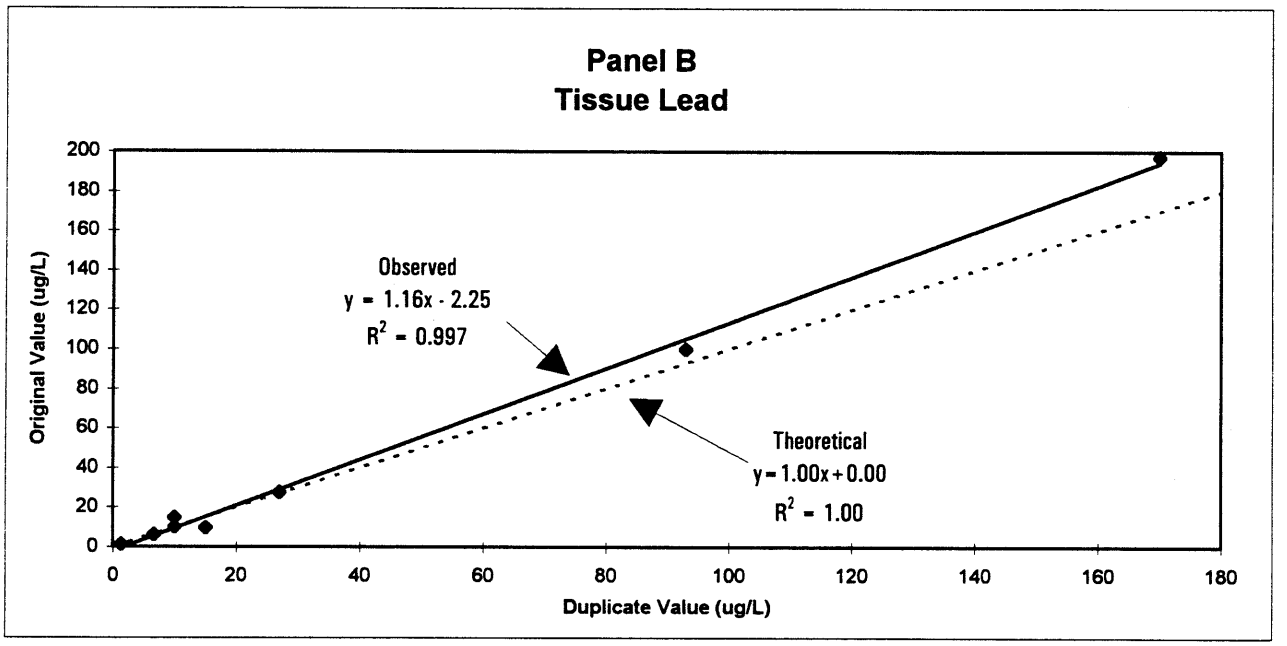
An interlaboratory comparison of blood lead analytical results was performed by sending a set of 30 randomly selected whole blood samples from this study to CDCP for blind independent preparation and analysis. The results are presented in Appendix A, and the values are plotted in Figure 3-2 (Panel B, lower). As seen, the results of analyses by EPA's laboratory and by CDPC were generally similar, with the slope of the linear regression line through the paired data has a slope near 1.0 and an R^2 value near 1.00. However, the EPA results tended to be slightly higher (an average of about 0.65 ug/dL) than the results from CDCP. The reason for the apparent difference in results between the EPA laboratory and the CDCP laboratory is not clear, but might be related to differences in sample preparation techniques. In any event, regardless of the reason, the differences are sufficiently small that they are likely to have no significant effect on calculated RBA values. In particular, it is important to realize that if both the lead acetate and test soils dose-response curves are biased by the same factor, then the biases cancel in the calculation of the RBA.

Data Audits and Spreadsheet Validation

All analytical data generated by EPA's analytical laboratory were validated prior to being released in the form of a database file. These electronic data files were "decoded" (linking the sample tag to the correct animal and day) using Microsoft's database system ACCESS® (Version 5 for Windows). To ensure that no errors occurred in this process, original downloaded electronic files were printed out and compared to printouts of the tag assignments and the decoded data. All spreadsheets used to manipulate the data and to perform calculations (see Appendix A) were validated by hand-checking random cells for accuracy.

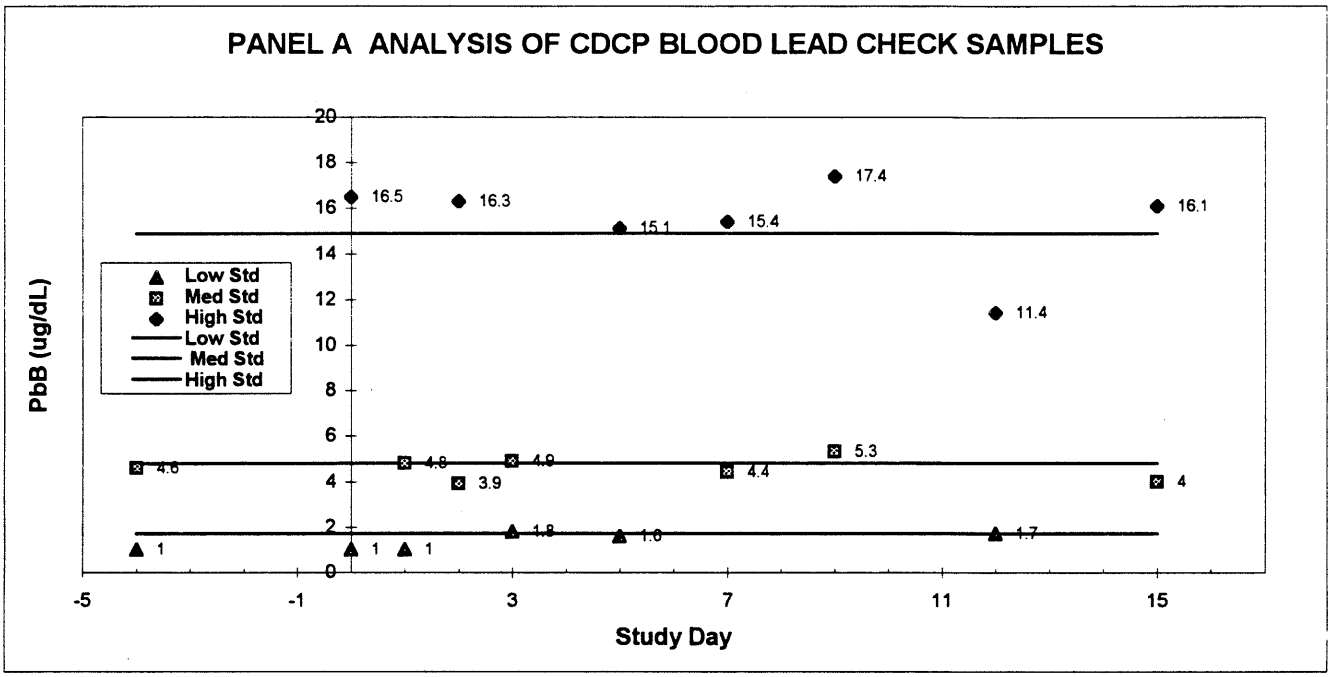
FIGURE 3-1 COMPARISION OF DUPLICATE ANALYSES
PHASE II EXPERIMENT 12

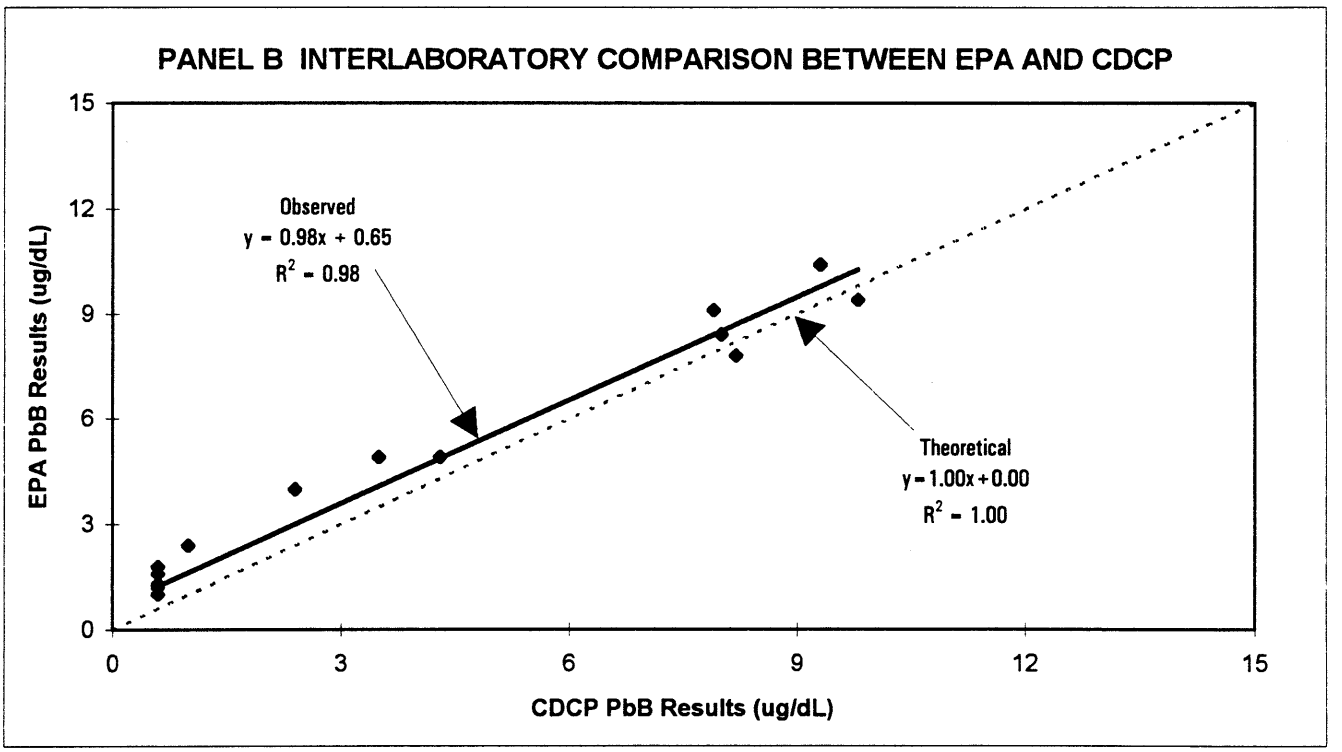




Blind random duplicates submitted at a 5% rate to EPA laboratories to provide a measure of analytical precision (reproducibility)

FIGURE 3-2 CDCP CHECK SAMPLES
PHASE II EXPERIMENT 12





4.0 RESULTS

The following sections provide results based on the group means for each dose group investigated in this study. Appendix A provides detailed data for each individual animal.

4.1 Blood Lead vs Time

Figure 4-1 shows the group mean blood lead values as a function of time during the study. As seen, blood lead values began below quantitation limits (about 1 ug/dL) in all groups, and remained close to or below quantitation limits in control animals (Group 1) and in galena-exposed animals (groups 5, 6 and 7). In animals given repeated oral doses of lead acetate (Groups 2, 3 and 4), blood levels began to rise within 1-2 days, and tended to plateau by the end of the study (day 15).

4.2 Dose-Response Patterns

Blood Lead

The measurement endpoint used to quantify the blood lead response was the area under the curve (AUC) for blood lead vs time (days 0-15). This AUC was calculated using the trapezoidal rule to estimate the AUC between each time point that a blood lead value was measured (days 0, 1, 2, 3, 5, 7, 9, 12, and 15), and summing the areas across all time intervals in the study. The detailed data and calculations are presented in Appendix A, and the results are shown graphically in Figure 4-2. Each data point reflects the group mean exposure and group mean response, with the variability in dose and response shown by standard error bars. The figure also shows the best-fit equation through each data set.

As seen, the dose response pattern is non-linear for lead acetate (abbreviated "PbAc"), while the response to the galena is so low that the shape can not be determined. Based on experience with other test materials, it is expected that the curve should ultimately be non-linear (at very high doses), so the curve was fit to an exponential equation. The very low response in animals exposed to the test material indicates that lead in galena is very poorly absorbed.

Tissue Lead

The dose-response data for lead levels in bone, liver and kidney (measured at sacrifice on day 15) are detailed in Appendix A, and are shown graphically in Figures 4-3 through 4-5, respectively. As seen, all of these tissue dose response curves are fit reasonably well by linear equations, with the responses (slopes) for the galena/soil test material being very low.

FIGURE 4-1 GROUP MEAN BLOOD LEAD BY DAY

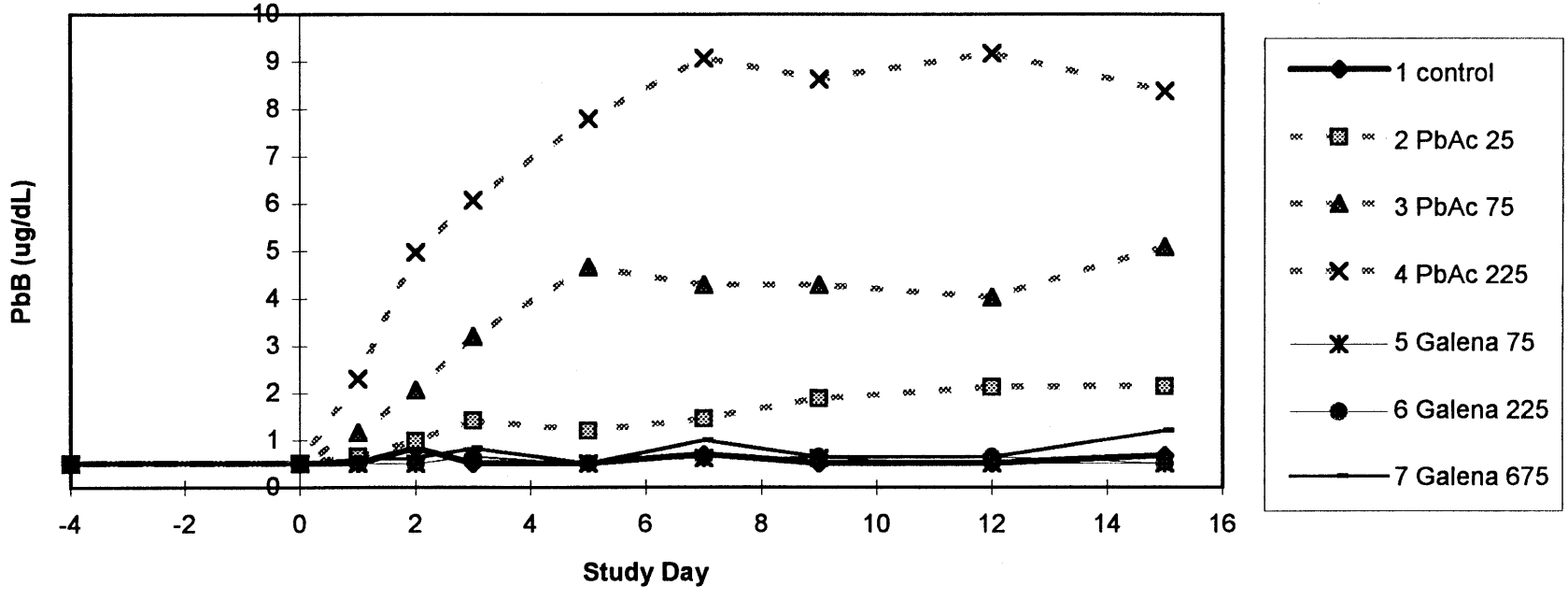
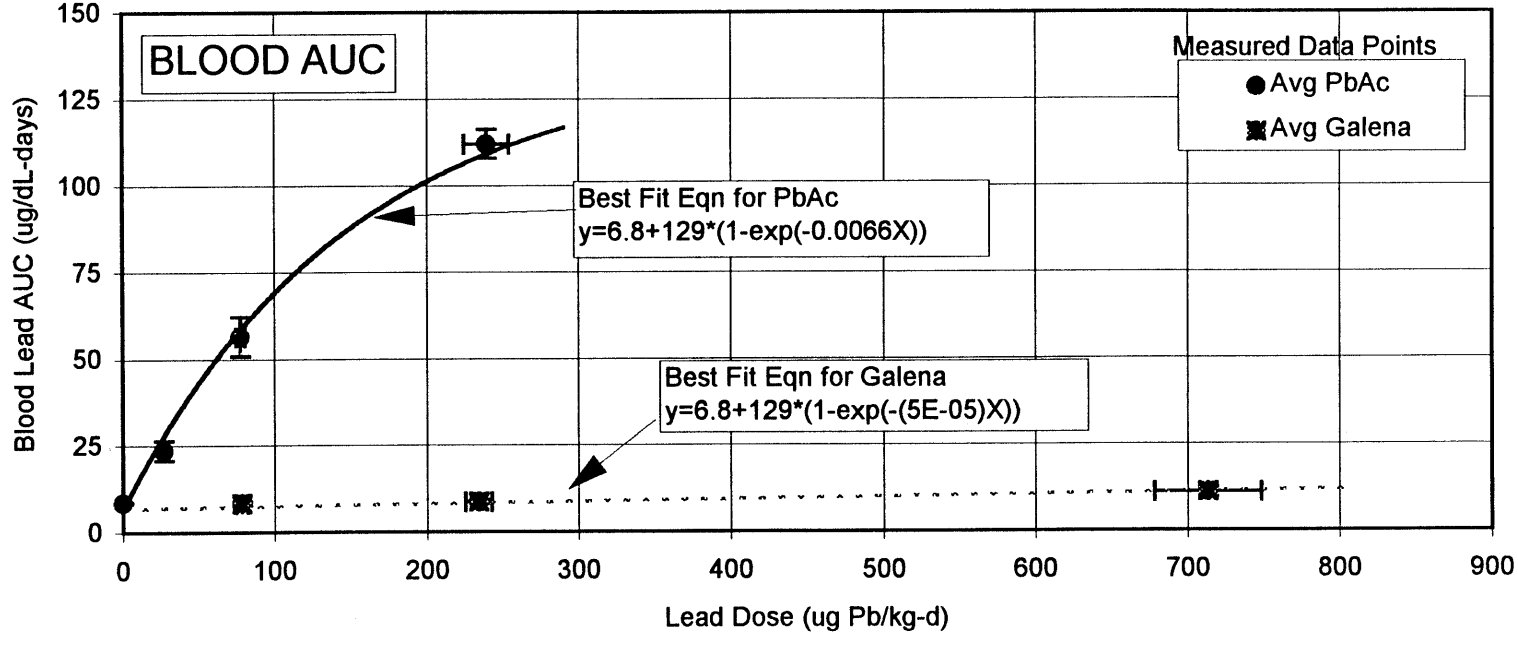


FIGURE 4-2 BLOOD LEAD DOSE-RESPONSE, GROUP MEANS ± SEM FOR GALENA ENRICHED SOIL



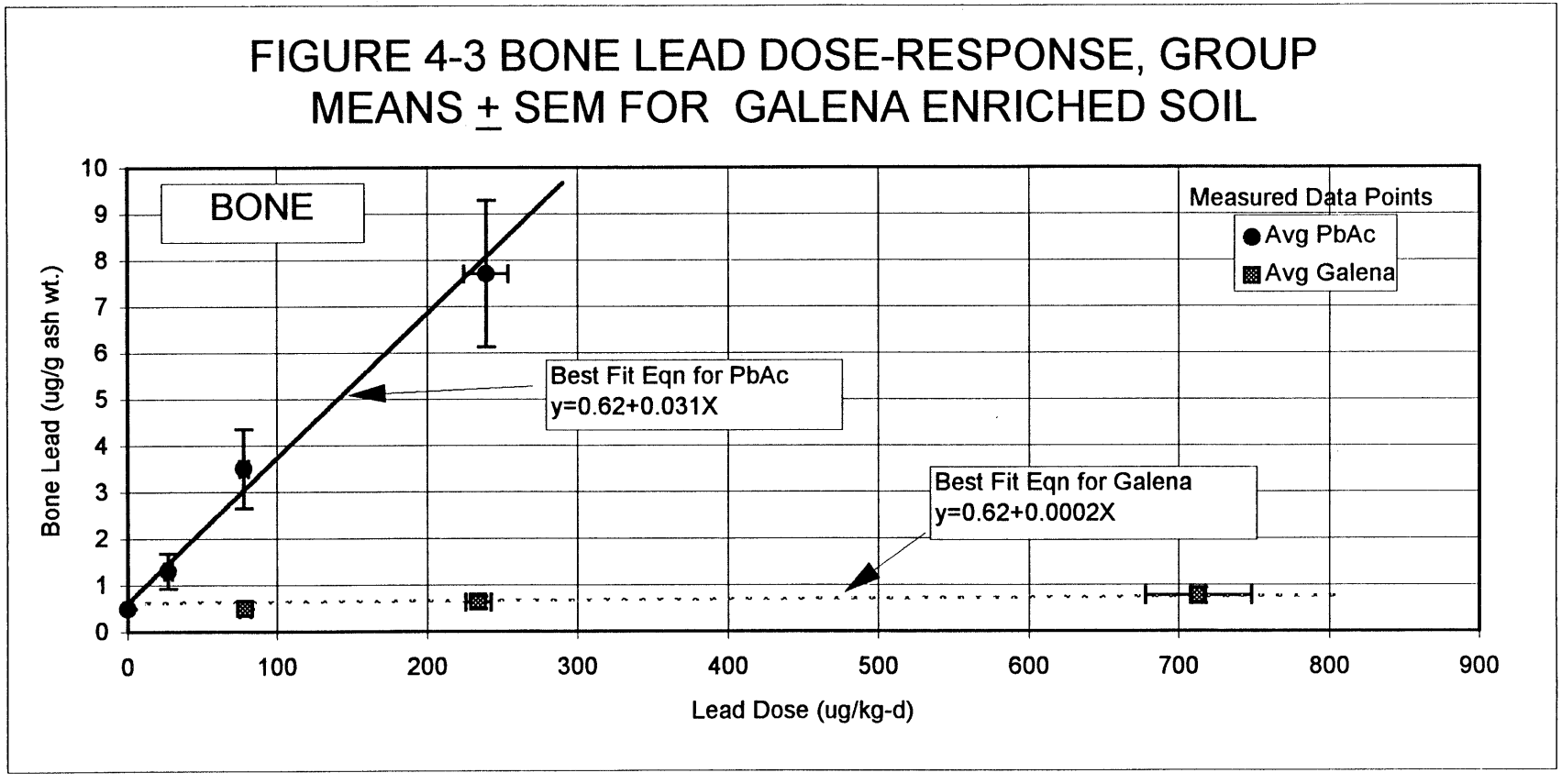


FIGURE 4-3 BONE LEAD DOSE-RESPONSE, GROUP MEANS ± SEM FOR GALENA ENRICHED SOIL
BONE
Measured Data Points
Avg PbAc
Avg Galena
Best Fit Eqn for PbAc
y=0.62+0.031X
Best Fit Eqn for Galena
y=0.62+0.0002X
Bone Lead (ug/g ash wt.)
Lead Dose (ug/kg-d)
0
1
2
3
4
5
6
7
8
9
10
0
100
200
300
400
500
600
700
800
900

FIGURE 4-4 LIVER LEAD DOSE-RESPONSE, GROUP MEANS ± SEM FOR GALENA ENRICHED SOIL

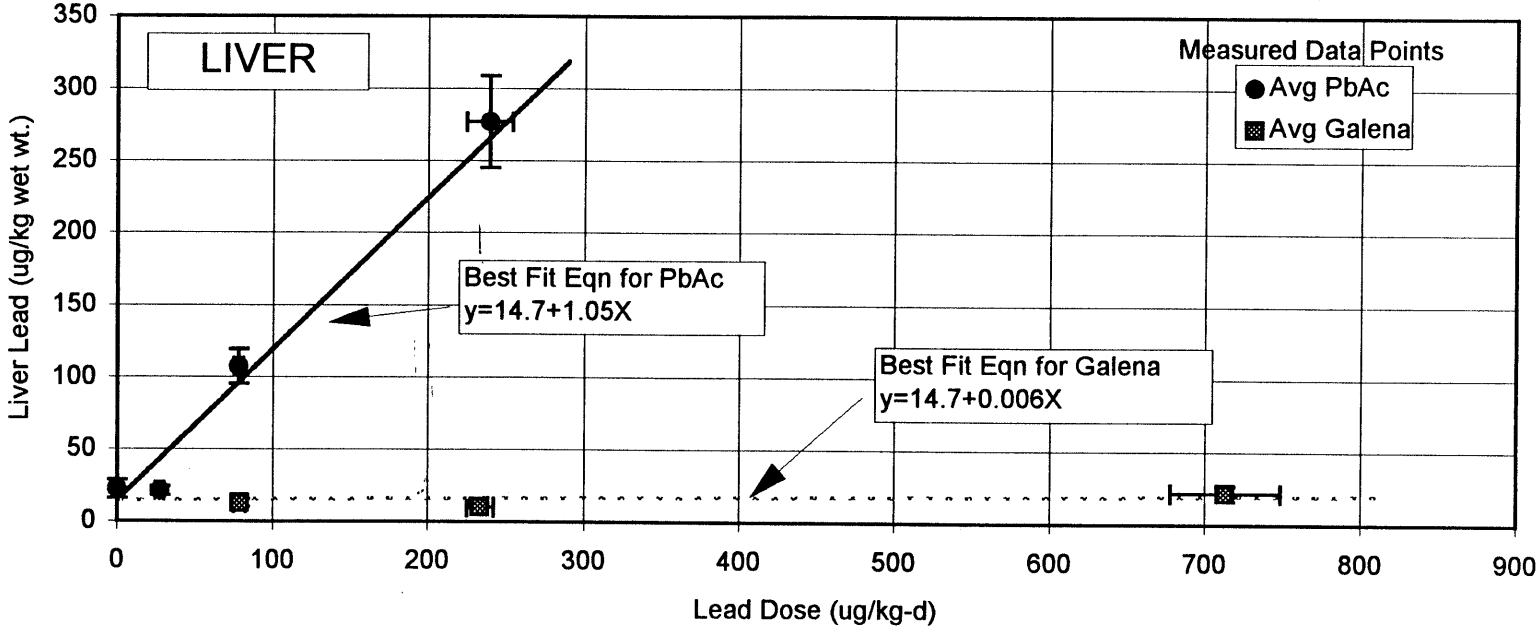
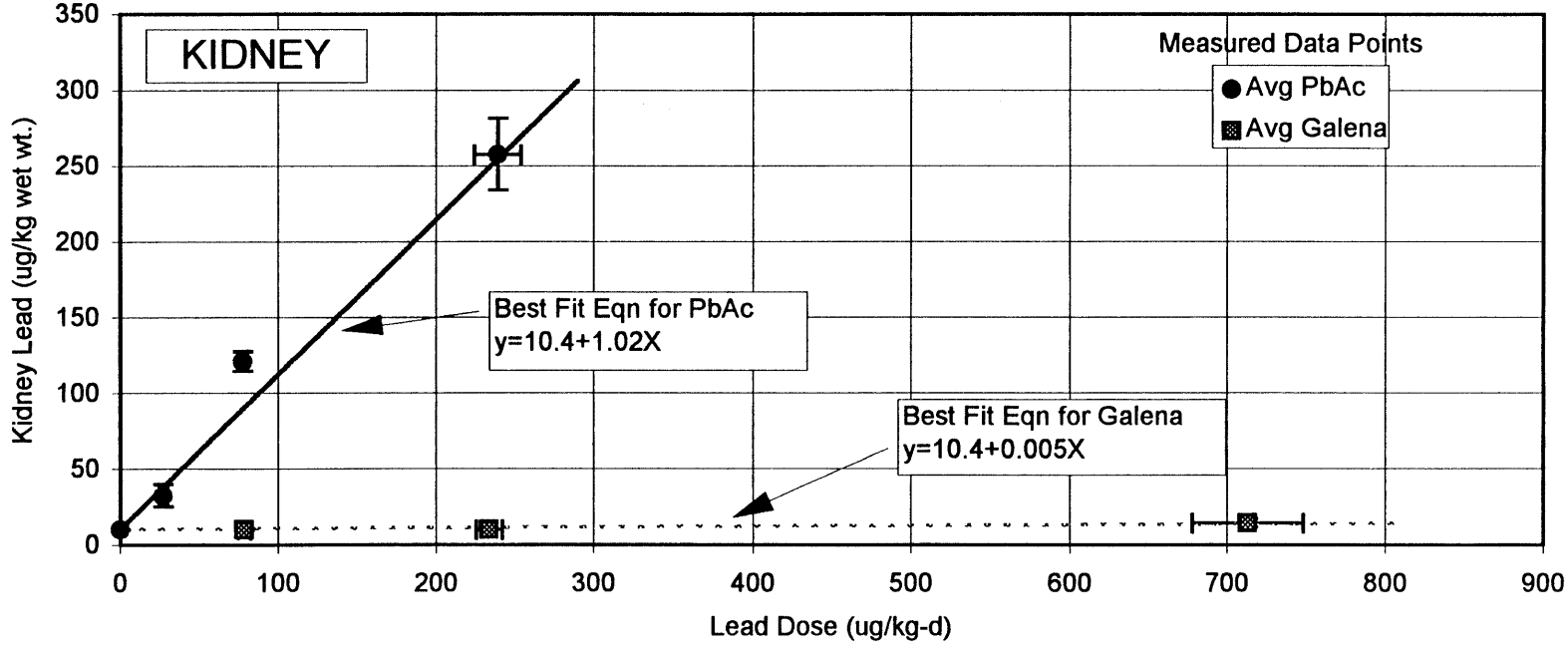


FIGURE 4-5 KIDNEY LEAD DOSE-RESPONSE, GROUP MEANS ± SEM FOR GALENA ENRICHED SOIL



4.3 Calculated RBA Values

Relative bioavailability values were calculated for lead in the galena/soil test material for each measurement endpoint (blood, bone, liver, kidney) using the method described in Section 3.0. The results are shown below:

Measurement Endpoint	RBA Estimate
Blood Lead AUC	0.01
Liver Lead	0.00
Kidney Lead	0.01
Bone Lead	0.01

Recommended RBA Value

As shown above, there are four independent estimates of RBA (based on blood, liver, kidney, and bone), and the values agree quite well in all cases. Based on these data, the RBA for galena is judged to be no more than 1%.

4.4 Estimated Absolute Bioavailability in Children

This RBA estimate may be used to help assess the potential lead risks which would exist if a child were exposed to soil containing galena with caharacteristics similar to the material tested here. The basic for estimating the ABA in children from the RBA value is follows:

$$ABA_{galena} = ABA_{soluble} \cdot RBA_{galena}$$

Available data indicate that fully soluble forms of lead are about 50% absorbed by a child (USEPA 1991, 1994). Thus, the estimated absolute bioavailability of lead in the galena sample is calculated as follows:

$$ABA_{galena} = 50\% \cdot RBA_{galena}$$

Based on the RBA value shown above, the absolute bioavailability of galena in children is probably no larger than about 0.5%.

4.5 Uncertainty

This absolute bioavailability estimate presented above would be appropriate for use in EPA's IEUBK model at a site where soil was contaminated with galena similar to that used in this study. However, it is important to emphasize that there are both variability and uncertainty associated with this estimate. This variability and uncertainty arises from several sources. First,

differences in physiological and pharmacokinetic parameters between individual animals leads to variability in response even when exposure is the same. Because of this inter-animal variability in the responses of different animals to lead exposure, there is mathematical uncertainty in the best fit dose-response curves for both lead acetate and test material. This in turn leads to uncertainty in the calculated values of RBA, because these are derived from the two best-fit equations. Second, there is uncertainty in the extrapolation of measured RBA values in swine to young children. Even though the immature swine is believed to be a useful and meaningful animal model for gastrointestinal absorption in children, it is possible that differences in stomach pH, stomach emptying time, and other physiological parameters may exist and that RBA values in swine may not be precisely equal to values in children. Third, there is uncertainty whether the RBA estimate derived for this particular galena/soil sample is applicable to galena occurring in all other types of soil. However, despite these qualitative and quantitative uncertainties, it seems very likely that the absorption of galena by children is likely to be quite low.

5.0 REFERENCES

Gibaldi, M. and Perrier, D. 1982. *Pharmacokinetics* (2nd edition) pp 294-297. Marcel Dekker, Inc, NY, NY.

Goodman, A.G., Rall, T.W., Nies, A.S., and Taylor, P. 1990. *The Pharmacological Basis of Therapeutics* (8th ed.) pp. 5-21. Pergamon Press, Inc. Elmsford, NY.

Klaassen, C.D., Amdur, M.O., and Doull, J. (eds). 1996. *Cassarett and Doulls Toxicology: The Basic Science of Poisons*. pp. 190. McGraw-Hill, Inc. NY,NY

LaVelle, J.M., Poppenga, R.H., Thacker, B.J., Giesy, J.P., Weis, C., Othoudt R, and Vandervoot C. 1991. Bioavailability of Lead in Mining Waste: An Oral Intubation Study in Young Swine. In: The Proceedings of the International Symposium on the Bioavailability and Dietary Uptake of Lead. Science and Technology Letters 3:105-111.

Mushak, P. 1991. Gastro-intestinal Absorption of Lead in Children and Adults: Overview of Biological and Biophysico-chemical Aspects. In: The Proceedings of the International Symposium on the Bioavailability and Dietary Uptake of Lead. Science and Technology Letters 3:87-104.

Sherlock, J.C., and Quinn, M.J. 1986. Relationship Between Blood Lead Concentration and Dietary Intake in Infants: the Glasgow Duplicate Diet Study 1979-1980. Food Additives and Contaminants 3:167-176.

USEPA 1991. Technical Support Document on Lead. United States Environmental Protection Agency, Environmental Criteria and Assessment Office. ECAO-CIN-757.

USEPA 1994. Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children. United States Environmental Protection Agency, Office of Emergency and Remedial Response. Publication Number 9285.7-15-1. EPA/540/R-93/081.

Weis, C.P. and LaVelle, J.M. 1991. Characteristics to consider when choosing an animal model for the study of lead bioavailability. In: The Proceedings of the International Symposium on the Bioavailability and Dietary Uptake of Lead. Science and Technology Letters 3:113-119.

Weis, C.P., Henningsen, G.M., Poppenga, R.H., and Thacker, B.J. 1993. Pharmacokinetics of Lead in Blood of Immature Swine Following Acute Oral and Intravenous Exposure. The Toxicologist 13(1):175.

Weis, C.P., Poppenga, R.H., Thacker, B.J., Henningsen, G.M., and Curtis, A. 1995. **"Design of Pharmacokinetic and Bioavailability Studies of Lead in an Immature Swine**

Model." **In:** LEAD IN PAINT, SOIL, AND DUST: HEALTH RISKS, EXPOSURE STUDIES, CONTROL MEASURES, MEASUREMENT METHODS, AND QUALITY ASSURANCE. ASTM STP 1226, Michael E. Beard and S. D. Allen Iske, Eds., American Society for Testing and Materials, Philadelphia, 1995.

APPENDIX A

DETAILED DATA AND CALCULATIONS FOR USEPA SWINE BIOAVAILABILITY STUDY PHASE II, EXPERIMENT 12

GALENA

APPENDIX A

DETAILED DATA SUMMARY

1.0 OVERVIEW

Performance of this study involved collection and reduction of a large number of data items. All of these data items and all of the data reduction steps are contained in a Microsoft Excel spreadsheet named "GALENA.XLS" that is available upon request from the administrative record. This file is intended to allow detailed review and evaluation by outside parties of all aspects of the study.

The following sections of this Appendix present printouts of selected tables and graphs from the XLS file. These tables and graphs provide a more detailed documentation of the individual animal data and the data reduction steps performed in this study than was presented in the main text. Any additional details of interest to a reader can be found in the XLS spreadsheet.

2.0 RAW DATA AND DATA REDUCTION STEPS

2.1 Body Weights and Dose Calculations

Animals were weighed on day -1 (one day before exposure) and every three days thereafter during the course of the study. Doses of lead for the three days following each weighing were based on the group mean body weight, adjusted by addition of 1 kg to account for the expected weight gain over the interval. After completion of the experiment, body weights were estimated by interpolation for those days when measurements were not collected, and the actual administered doses (ug Pb/kg) were calculated for each day and then averaged across all days. If an animal missed a dose or was given an incorrect dose, the calculation of average dose corrected for these factors. These data and data reduction steps are shown in Tables A-1 and A-2.

2.2 Blood Lead vs Time

Blood lead values were measured in each animal on days -4, 0, 1, 2, 3, 5, 7, 9, 12, and 15. The raw laboratory data (reported as ug/L of diluted blood) are shown in Table A-3. These data were adjusted as follows: a) non-detects were evaluated by assuming a value equal to one-half the quantitation limit, and b) the concentrations in diluted blood were converted to units of ug/dL in whole blood by dividing by a factor of 1 dL of blood per L of diluted sample. The results are shown in the right-hand column of Table A-3. Figures A-1 and A-2 plot the results for individual animals organized by group and by day. Figure A-4 plots the mean for each dosing group by day.

After adjustment as above, values that were more than a factor of 1.5 above or below the group mean for any given day were "flagged" by computer as potential outliers. These values are shown in Table A-4 by cells that are shaded gray. Each data point identified in this way was reviewed and professional judgement was used to decide if the value should be retained or excluded. In order to avoid inappropriate biases, blood lead outlier designations were restricted to values that were clearly aberrant from a time-course and/or dose-response perspective. Those which were judged to warrant exclusion are shown by a heavy black box around the value. All other flagged values were retained.

Rarely, a value not flagged by the computer was judged to be an outlier that should be excluded. These are shown by unshaded cells surrounded by a heavy black box.

Table A-5 provided a discussion of the rationale used to decide if a blood lead value should be designated as an outlier or not.

2.3 Blood Lead AUC

The area under the blood lead vs time curve for each animal was calculated by finding the area under the curve for each time step using the trapezoidal rule:

$$AUC(d_i \text{ to } d_j) = 0.5*(r_i+r_j)*(d_j-d_i)$$

where:

d = day number
r = response (blood lead value) on day i (r_i) or day j (r_j)

The areas were then summed for each of the time intervals to yield the final AUC for each animal. These calculations are shown in Table A-6. If a blood lead value was missing (either because of problems with sample preparation, or because the measured value was excluded as an outlier), the blood lead value for that day was estimated by linear interpolation.

2.4 Liver, Kidney and Bone Lead Data

At sacrifice (day 15), samples of liver, kidney and bone (femur) were removed and analyzed for lead. The raw data (expressed as ug Pb/L of prepared sample) are summarized in Table A-7. These data were adjusted as follows: a) non-detects were evaluated by assuming a value equal to one-half the quantitation limit, and b) the concentrations in prepared sample were converted to units of concentration in the original biological sample by dividing by the following factors:

Liver:	0.1 kg wet weight/L prepared sample
Kidney:	0.1 kg wet weight/L prepared sample
Bone:	2 gm ashed weight/L prepared sample

The resulting values are shown in the right-hand column of Table A-7.

3.0 CURVE FITTING

Basic Equations

A commercial curve-fitting program (Table Curve-2D™ Version 2.0 for Windows, available from Jandel Scientific) was used to derive best fit equations for each of the individual dose-response data sets derived above. A least squares regression method was used for both linear and non-linear equations. As discussed in the text, three different user-defined equations were fit to each data set:

Linear (LIN): $\text{Response} = a + b \cdot \text{Dose}$

Exponential (EXP): $\text{Response} = a + c \cdot (1-\exp(-d \cdot \text{Dose}))$

Combination (LIN+EXP): $\text{Response} = a + b \cdot \text{Dose} + c \cdot (1-\exp(-d \cdot \text{Dose}))$

Constraints

In the process of finding the best-fits of these equations to the data, the values of the parameters (a, b, c, and d) were constrained as follows:

- Parameter "a" (the intercept, equal to the baseline or control value of the measurement endpoint) was constrained to be non-negative and was forced in all cases to be the same for the reference material (lead acetate) and the test materials. This is because, by definition, all dose-response curves for groups of animals exposed to different materials must arise from the same value at zero dose. In addition, for blood lead data, "a" was constrained to be equal to the mean of the control group $\pm$ 20% (typically 7.5 $\pm$ 1.5 AUC units).

- Parameter "b" (the slope of the linear dose-response line) was constrained to non-negative values, since all of the measurement endpoints evaluated are observed to increase, not decrease, as a function of lead exposure.

- Parameter "c" (the plateau value of the exponential curve) was constrained to be non-negative, and was forced to be the same for the reference material (lead acetate) and the test material. This is because: 1) it is expected on theoretical grounds that the plateau (saturation level) should be the same regardless of the source of lead, and 2) curve-fitting of individual curves tended to yield values of "c" that were close to each other and were not statistically different.

- Parameter "d" (which determines where the "bend" in the exponential equation occurs) was constrained to be greater than 0.0045 for the lead acetate blood lead (AUC) dose-response curve. This constraint was judged to be necessary because the weight of evidence from all studies clearly showed the lead acetate blood lead dose response curve was non-linear and was best fit by an exponential equation, but in some studies there were only two low doses of lead acetate used to define the dose-response curve, and this narrow range data set could sometimes be fit nearly as well by a linear as an exponential curve. The choice of the constraint on "d" was selected to be slightly lower than the observed best-fit value of "d" (0.006) when data from all lead acetate AUC dose-response curves from all of the different studies in this program were used. This approach may tend to underestimate relative bioavailability slightly in some studies (especially at low doses), but use of the information gained from all studies is judged to be more robust than basing fits solely on the data from one study.

In general, one of these models (the linear, the exponential, or the combination) usually yielded a fit (as judged by the value of the adjusted correlation coefficient R^2 and by visual inspection of the fit of the line through the measured data points) that was clearly superior to the others. If two or more models fit the data approximately equally well, then the simplest model (that with the fewest parameters) was selected.

Outlier Identification

During the dose-response curve fitting process, all data were carefully reviewed to identify any anomalous values. Typically, the process used to identify outliers was as follows:

Step 1 — Any data points judged to be outliers based on information derived from analysis of data across multiple studies (as opposed to conclusions drawn from within the study) were excluded.

Step 2 — The remaining raw data points were fit to the equation judged to be the most likely to be the best fit (linear, exponential, or mixed). Table Curve 2-D was then used to plot the 95% prediction limits around the best fit line. All data points that fell outside the 95% prediction limits were considered to be outliers and were excluded.

Step 3 — After excluding these points (if any), a new best-fit was obtained. In some cases, data points originally inside the 95% prediction limits were now outside the limits. However, further iterative cycles of data point exclusion were not performed, and the fit was considered final.

Curve Fit Results

Table A-8 lists the data used to fit these curves, indicating which endpoints were excluded as outliers and why. Table A-9 shows the type of equation selected to fit each data set, and the best fit parameters. The resulting best-fit equations for the data sets are shown in Figures A-5 to A-16. Values excluded as outliers are represented in the figures by the symbol "+".

4.0 RESULTS -- CALCULATED RBA VALUES

The value of RBA for a test substance was calculated for a series of doses using the following procedure:

1. For each dose, calculate the expected response to test material, using the best fit equation through the dose-response data for that material.

2. For each expected response to test material, calculate the dose of lead acetate that is expected to yield an equivalent response. This is done by "inverting" the dose-response curve for lead acetate, and solving for the dose that corresponds to a specified response.

3. Calculate RBA at that dose as the ratio of the dose of lead acetate to the dose of test material. For the situation where both curves are linear, the value of RBA is the ratio of the slopes (the "b" parameters). In the case where both curves are exponential and where both curves have the same values for parameters "a" and "c", the value of RBA is equal to the ratio of the "d" parameters.

The results are summarized in Table A-10.

5.0 QUALITY ASSURANCE DATA

A number of steps were taken throughout this study and the other studies in this project to ensure the quality of the results, including 5% duplicates, 5% standards, and a program of interlaboratory comparison. These steps are detailed below.

Duplicates

Duplicate samples were prepared and analyzed for about 5% of all samples generated during the study. Table A-11 lists the first and second values for blood, liver, kidney, and bone. The results are shown in Figure 3-1 in the main text.

Standards

The Centers for Disease Control and Prevention (CDCP) provide a variety of blood lead "check samples" for use in quality assurance programs for blood lead studies. Each time a group of

blood samples was prepared and sent to the laboratory for analysis, several CDCP check samples of different concentrations were included. Table A-12 lists the concentrations reported by the laboratory compared to the nominal concentrations indicated by CDCP for the samples submitted during this study, and the results are plotted in Figure 3-2 (Panel A) in the main text.

Interlaboratory Comparison

An interlaboratory comparison of blood lead analytical results was performed by sending a set of 15 randomly selected whole blood samples from this study to CDCP for independent analysis. The data are presented in Table A-13, and the results are plotted in Figure 3-2 (Panel B) in the main text.

DISK INSTRUCTIONS

Enclosed is a disk entitled "GALENA.EXE". This disk contains a Microsoft Excel spreadsheet named "GALENA.XLS" that contains all of the data items and all of the data reduction steps for animals exposed to the galena test material. This file is intended to allow detailed review and evaluation by outside parties of all aspects of the study. In order to conserve space and help guard against accidental changes in the spreadsheet, all of the formulas and links present in the original spreadsheet used by EPA have been "frozen". Thus, the values shown in the attached file represent the final values employed by EPA. Due to the size of the file (approximately 2 MB), it has been provided as a self-extracting zipped file. To extract the file from the enclosed disk to a location on your hard drive, the following steps should be taken:

1) Go to the DOS Prompt
2) Change directory to desired destination directory (e.g., C:\data)
3) Place the source disk in the appropriate drive (e.g., A:)
4) At the DOS prompt (C:\data>) type "A:\GALENA" and press enter. This will cause the GALENA.XLS file to extract from your source disk (A:) to your destination directory (C:\data).
5) Open Microsoft Excel to view the unzipped file. Note that even though the formulas have been frozen, the file remains quite large, so it is recommended that the user have a minimum of 8 MB of RAM to facilitate use of this spreadsheet.

TABLE A-1 BODY WEIGHTS AND ADMINISTERED DOSES, BY DAY

Body weights were measured on days -1, 2, 5, 8, 11, 14. Weights for other days are estimated, based on linear interpolation between measured values.

Group	ID #	Day -1		Day 0		Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7		Day 8		Day 9		Day 10		Day 11		Day 12		Day 13		Day 14		Day 15	
		BW (kg)	ug Pb per day	BW (kg)	ug Pb per day	BW (kg)	ug Pb per day	BW (kg)	ug Pb per day	BW (kg)	ug Pb per day	BW (kg)	ug Pb per day	BW (kg)	ug Pb per day	BW (kg)	ug Pb per day	BW (kg)	ug Pb per day	BW (kg)	ug Pb per day	BW (kg)	ug Pb per day	BW (kg)	ug Pb per day	BW (kg)	ug Pb per day	BW (kg)	ug Pb per day	BW (kg)	ug Pb per day	BW (kg)	ug Pb per day	BW (kg)	ug Pb per day
1	1205	10.28	0.0	10.4	0.0	10.6	0.0	10.7	0.0	11.0	0.0	11.2	0.0	11.5	0.0	11.9	0.0	12.2	0.0	12.62	0.0	13.1	0.0	13.5	0.0	13.94	0.0	14.4	0.0	14.9	0.0	15.38	0.0	15.9	0.0
1	1228	8.24	0.0	8.5	0.0	8.7	0.0	8.96	0.0	9.3	0.0	9.7	0.0	10.02	0.0	10.3	0.0	10.5	0.0	10.72	0.0	11.0	0.0	11.3	0.0	11.54	0.0	11.9	0.0	12.2	0.0	12.56	0.0	12.9	0.0
1	1236	7.96	0.0	8.0	0.0	8.1	0.0	8.2	0.0	8.4	0.0	8.6	0.0	8.82	0.0	9.3	0.0	9.9	0.0	10.38	0.0	10.4	0.0	10.4	0.0	10.48	0.0	10.7	0.0	10.9	0.0	11.12	0.0	11.3	0.0
2	1208	10.5	0.0	10.4	238.5	10.2	238.5	10.08	238.5	10.6	241.5	11.1	241.5	11.64	241.5	11.9	264.1	12.2	264.1	12.42	264.1	12.7	291.6	13.0	291.6	13.28	291.6	13.5	314.3	13.8	314.3	14.06	314.3	14.3	0.0
2	1213	6.22	0.0	6.4	238.5	6.5	238.5	6.7	238.5	7.0	241.5	7.3	241.5	7.64	241.5	8.0	264.1	8.3	264.1	8.58	264.1	8.8	291.6	9.0	291.6	9.26	291.6	9.5	314.3	9.7	314.3	9.92	314.3	10.1	0.0
2	1215	10.16	0.0	10.2	238.5	10.3	238.5	10.34	238.5	10.6	241.5	10.8	241.5	11	241.5	11.3	264.1	11.6	264.1	11.92	264.1	12.2	291.6	12.4	291.6	12.64	291.6	13.1	314.3	13.7	314.3	14.16	314.3	14.7	0.0
2	1217	6.06	0.0	6.1	238.5	6.2	119.3	6.28	238.5	6.5	360.8	6.8	241.5	7.06	241.5	7.5	264.1	7.9	264.1	8.32	264.1	8.7	291.6	9.0	291.6	9.34	291.6	9.6	314.3	9.8	314.3	10.1	314.3	10.4	0.0
2	1248	9.76	0.0	9.8	238.5	9.9	238.5	9.9	238.5	10.1	241.5	10.3	241.5	10.48	241.5	11.0	264.1	11.5	264.1	12.08	264.1	12.5	291.6	12.9	291.6	13.34	291.6	13.7	314.3	14.1	314.3	14.52	314.3	14.9	0.0
3	1227	9.7	0.0	9.8	695.1	9.9	695.1	10.04	695.1	10.2	747.3	10.5	747.3	10.66	747.3	11.1	796.8	11.6	796.8	12.04	796.8	12.5	884.4	13.0	884.4	13.48	884.4	14.0	991.8	14.5	991.8	15.06	991.8	15.6	0.0
3	1240	8.12	0.0	8.3	695.1	8.4	695.1	8.58	695.1	8.9	747.3	9.1	747.3	9.4	747.3	9.7	796.8	10.0	796.8	10.36	796.8	10.8	884.4	11.3	884.4	11.7	884.4	12.2	991.8	12.6	991.8	13.1	991.8	13.6	0.0
3	1243	8	0.0	8.2	695.1	8.4	695.1	8.66	695.1	9.0	747.3	9.3	747.3	9.56	747.3	9.9	796.8	10.2	796.8	10.46	796.8	10.8	884.4	11.2	884.4	11.54	884.4	12.0	991.8	12.4	991.8	12.88	991.8	13.3	0.0
3	1244	8.58	0.0	8.9	695.1	9.2	695.1	9.58	695.1	9.8	747.3	10.0	747.3	10.2	747.3	10.6	796.8	11.0	796.8	11.34	796.8	11.9	884.4	12.5	884.4	13.14	884.4	13.6	991.8	14.1	991.8	14.64	991.8	15.1	0.0
3	1255	6.94	0.0	7.3	695.1	7.6	695.1	7.96	695.1	8.1	747.3	8.2	747.3	8.3	747.3	8.8	796.8	9.3	796.8	9.76	796.8	10.3	884.4	10.8	884.4	11.26	884.4	11.9	991.8	12.4	991.8	13.04	991.8	13.6	0.0
4	1222	6.02	0.0	6.1	1748.7	6.2	1748.7	6.34	1748.7	7.3	1871.1	8.3	1871.1	9.3	1871.1	8.9	2181.6	8.5	2181.6	8.12	2181.6	8.3	2309.4	8.6	2309.4	8.8	2309.4	9.1	2562.3	9.4	2562.3	9.72	2562.3	10.0	0.0
4	1225	5.84	0.0	6.1	1748.7	6.4	1748.7	6.62	1748.7	6.8	1871.1	7.0	1871.1	7.22	1871.1	7.5	2181.6	7.8	2181.6	8.1	2181.6	8.4	2309.4	8.7	2309.4	8.98	2309.4	9.3	2562.3	9.6	2562.3	9.9	2562.3	10.2	0.0
4	1226	6.28	0.0	6.4	1748.7	6.6	1748.7	6.7	1748.7	7.1	1871.1	7.5	1871.1	7.88	1871.1	8.2	2181.6	8.4	2181.6	8.7	2181.6	9.0	2309.4	9.3	2309.4	9.66	2309.4	10.0	2562.3	10.4	2562.3	10.72	2562.3	11.1	0.0
4	1241	7.52	0.0	7.6	1748.7	7.8	1748.7	7.88	1748.7	8.2	1871.1	8.5	1871.1	8.84	1871.1	9.3	2181.6	9.7	2181.6	10.2	2181.6	10.7	2309.4	11.2	2309.4	11.76	2309.4	12.2	2562.3	12.6	2562.3	13.08	2562.3	13.5	0.0
4	1249	8.2	0.0	8.5	1748.7	8.8	1748.7	9.04	1748.7	9.4	1871.1	9.8	1871.1	10.24	1871.1	10.6	2181.6	10.9	2181.6	11.2	2181.6	11.7	2309.4	12.2	2309.4	12.74	2309.4	13.1	2562.3	13.5	2562.3	13.94	2562.3	14.3	0.0
5	1201	7.02	0.0	7.1	627.9	7.1	627.9	7.12	627.9	7.5	645.6	7.8	645.6	8.2	645.6	8.6	725.1	8.9	725.1	9.26	725.1	9.7	809.1	10.2	809.1	10.64	809.1	11.2	916.5	11.7	916.5	12.28	916.5	12.8	0.0
5	1233	6.36	0.0	6.4	627.9	6.5	627.9	6.58	627.9	7.2	645.6	7.7	645.6	8.32	645.6	8.6	725.1	8.9	725.1	9.2	725.1	9.6	809.1	10.1	809.1	10.52	809.1	11.0	916.5	11.4	916.5	11.86	916.5	12.3	0.0
5	1250	6.4	0.0	6.5	627.9	6.6	627.9	6.7	627.9	7.0	645.6	7.3	645.6	7.62	645.6	8.0	725.1	8.3	725.1	8.7	725.1	9.2	809.1	9.7	809.1	10.14	809.1	10.6	916.5	11.1	916.5	11.62	916.5	12.1	0.0
5	1251	8.74	0.0	8.9	627.9	9.0	627.9	9.14	627.9	9.4	645.6	9.6	645.6	9.84	645.6	10.2	725.1	10.6	725.1	11	725.1	11.5	809.1	12.0	809.1	12.46	809.1	12.9	916.5	13.4	916.5	13.88	916.5	14.4	0.0
5	1253	8.34	0.0	8.4	627.9	8.4	627.9	8.5	627.9	8.8	645.6	9.1	645.6	9.36	645.6	9.8	725.1	10.3	725.1	10.78	725.1	11.3	809.1	11.8	809.1	12.34	809.1	12.9	916.5	13.4	916.5	13.98	916.5	14.5	0.0
6	1203	7.52	0.0	7.4	1913.4	7.3	1913.4	7.26	1913.4	7.6	2024.1	7.9	2024.1	8.24	2024.1	8.5	2246.4	8.8	2246.4	9.12	2246.4	9.7	2493.9	10.3	2493.9	10.86	2493.9	11.2	2851.2	11.5	2851.2	11.76	2851.2	12.1	0.0
6	1209	6.46	0.0	6.7	1913.4	6.9	1913.4	7.06	1913.4	7.4	2024.1	7.7	2024.1	8.08	2024.1	8.5	2246.4	8.9	2246.4	9.36	2246.4	10.0	2493.9	10.6	2493.9	11.26	2493.9	11.7	2851.2	12.1	2851.2	12.48	2851.2	12.9	0.0
6	1214	7.52	0.0	7.8	1913.4	8.1	1913.4	8.38	1913.4	8.7	2024.1	9.1	2024.1	9.46	2024.1	9.8	2246.4	10.2	2246.4	10.62	2246.4	11.3	2493.9	11.9	2493.9	12.52	2493.9	13.0	2851.2	13.5	2851.2	14.02	2851.2	14.5	0.0
6	1231	7.58	0.0	7.8	1913.4	7.9	1913.4	8.1	1913.4	8.4	2024.1	8.7	2024.1	9.04	2024.1	9.5	2246.4	9.9	2246.4	10.34	2246.4	10.7	2493.9	11.0	2493.9	11.32	2493.9	11.8	2851.2	12.2	2851.2	12.62	2851.2	13.1	0.0
6	1247	8.44	0.0	8.7	1913.4	8.9	1913.4	9.18	1913.4	9.5	2024.1	9.8	2024.1	10.1	2024.1	10.4	2246.4	10.7	2246.4	10.98	2246.4	11.5	2493.9	11.9	2493.9	12.4	2493.9	12.9	2851.2	13.3	2851.2	13.8	2851.2	14.3	0.0
7	1218	6.58	0.0	6.8	5805.0	7.0	5805.0	7.22	5805.0	7.5	6266.7	7.9	6266.7	8.18	6266.7	8.3	6968.7	8.4	6968.7	8.58	6968.7	8.9	7260.3	9.2	7260.3	9.52	7260.3	9.9	8013.6	10.3	8013.6	10.66	8013.6	11.0	0.0
7	1229	8.14	0.0	8.2	5805.0	8.3	5805.0	8.38	5805.0	8.8	6266.7	9.1	6266.7	9.5	6266.7	9.6	6968.7	9.7	6968.7	9.76	6968.7	9.9	7260.3	10.1	7260.3	10.2	7260.3	10.5	8013.6	10.8	8013.6	11.04	8013.6	11.3	0.0
7	1235	8.4	0.0	8.7	5805.0	9.1	5805.0	9.38	5805.0	9.9	6266.7	10.4	6266.7	10.96	6266.7	10.7	6968.7	10.5	6968.7	10.32	6968.7	11.0	7260.3	11.6	7260.3	12.28	7260.3	12.8	8013.6	13.3	8013.6	13.76	8013.6	14.3	0.0
7	1237	6.3	0.0	6.6	5805.0	7.0	5805.0	7.34	5805.0	7.5	6266.7	7.7	6266.7	7.9	6266.7	8.3	6968.7	8.6	6968.7	8.98	6968.7	9.5	7260.3	9.9	7260.3	10.4	7260.3	11.0	8013.6	11.5	8013.6	12.12	8013.6	12.7	0.0
7	1254	8.58	0.0	8.8	5805.0	8.9	5805.0	9.1	5805.0	9.4	6266.7	9.8	6266.7	10.08	6266.7	10.4	6968.7	10.8	6968.7	11.14	6968.7	11.4	7260.3	11.7	7260.3	11.96	7260.3	12.2	8013.6	12.4	8013.6	12.56	8013.6	12.8	0.0

Shaded boxes show days in which administered doses were ingested late

Days which required adjustment due to deviations in dosing (ie. Missed doses)

Day 1 Pig 1217 - did not eat pm dose until next morning. Dose adjusted to 50%

Day 2 Pig 1217 - Ate pm dose from Day 1, Did not eat pm dose for Day 2 until next day.

Day 3 Pig 1217 - Ate pm dose from Day 2 in addition to normal daily doses. Dose adjusted to account for previous day doughball

TABLE A-2

Body Weight Adjusted Doses

(Dose for Day/BW for Day)

Group	ID #	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10	Day 11	Day 12	Day 13	Day 14	Avg Dose	Target Dose	% Target	Avg %
1	1205	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0		
1	1228	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0		
1	1236	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0		
2	1208	23.02	23.34	23.66	22.78	21.72	20.75	22.19	21.72	21.26	22.95	22.44	21.96	23.21	22.78	22.35	22.4	25	90	
2	1213	37.38	36.47	35.60	34.43	32.96	31.61	33.21	31.95	30.78	33.11	32.28	31.49	33.15	32.40	31.68	33.2	25	133	
2	1215	23.34	23.20	23.07	22.87	22.40	21.95	23.36	22.74	22.16	23.98	23.52	23.07	23.91	23.02	22.20	23.0	25	92	
2	1217	38.89	19.21	37.98	55.16	35.51	34.21	35.31	33.43	31.74	33.67	32.40	31.22	32.76	31.92	31.12	34.3	25	137	
2	1248	24.32	24.21	24.09	23.93	23.48	23.04	23.98	22.87	21.86	23.33	22.57	21.86	22.89	22.25	21.65	23.1	25	92	109
3	1227	70.83	70.02	69.23	72.93	71.49	70.10	71.65	68.81	66.18	70.64	68.03	65.61	70.81	68.24	65.86	69.4	75	92	
3	1240	84.02	82.49	81.01	84.41	81.88	79.50	81.98	79.36	76.91	81.84	78.59	75.59	81.52	78.51	75.71	80.2	75	107	
3	1243	84.56	82.36	80.27	83.40	80.70	78.17	80.81	78.43	76.18	81.74	79.11	76.64	82.74	79.77	77.00	80.1	75	107	
3	1244	77.98	75.17	72.56	76.36	74.78	73.26	75.31	72.70	70.26	74.07	70.53	67.31	72.71	70.14	67.75	72.7	75	97	
3	1255	95.48	91.22	87.32	92.56	91.28	90.04	90.68	85.92	81.64	86.20	82.19	78.54	83.67	79.68	76.06	86.2	75	115	104
4	1222	285.42	280.54	275.82	255.38	225.07	201.19	244.94	256.26	268.67	276.69	269.37	262.43	281.37	272.20	263.61	261.3	225	116	
4	1225	286.67	274.95	264.15	274.35	266.54	259.16	290.36	279.45	269.33	275.15	265.86	257.17	275.91	267.09	258.82	271.0	225	120	
4	1226	272.38	266.57	261.00	263.78	249.92	237.45	267.57	258.89	250.76	256.03	247.26	239.07	255.89	247.17	239.02	254.2	225	113	
4	1241	228.89	225.35	221.92	228.18	219.61	211.66	234.75	223.83	213.88	215.43	205.46	196.38	210.02	202.71	195.89	215.6	225	96	
4	1249	206.21	199.62	193.44	198.21	190.15	182.72	206.59	200.51	194.79	197.16	188.88	181.27	195.00	189.24	183.81	193.8	225	86	106
5	1201	89.02	88.60	88.19	86.31	82.35	78.73	84.77	81.41	78.30	83.24	79.48	76.04	81.93	78.11	74.63	82.1	75	109	
5	1233	97.60	96.50	95.43	90.17	83.41	77.60	84.18	81.41	78.82	83.93	80.27	76.91	83.57	80.30	77.28	84.5	75	113	
5	1250	96.60	95.14	93.72	92.14	88.28	84.72	90.86	86.94	83.34	88.14	83.76	79.79	86.19	82.37	78.87	87.4	75	117	
5	1251	70.76	69.72	68.70	68.88	67.20	65.61	70.90	68.32	65.92	70.44	67.58	64.94	70.86	68.36	66.03	68.3	75	91	
5	1253	74.81	74.34	73.87	73.47	71.15	68.97	73.74	70.35	67.26	71.60	68.45	65.57	71.12	68.23	65.56	70.6	75	94	105
6	1203	257.41	260.44	263.55	266.80	255.78	245.64	263.25	254.50	246.32	257.10	242.60	229.64	255.48	248.80	242.45	252.7	225	112	
6	1209	287.30	278.92	271.02	273.53	261.51	250.51	264.08	251.46	240.00	249.56	234.68	221.48	244.39	236.16	228.46	252.9	225	112	
6	1214	245.10	236.42	228.33	231.59	222.43	213.96	228.14	219.52	211.53	221.61	209.81	199.19	218.99	210.89	203.37	220.1	225	98	
6	1231	246.78	241.39	236.22	240.58	231.94	223.90	237.13	226.76	217.25	233.80	226.86	220.31	242.59	233.96	225.93	232.4	225	103	
6	1247	220.27	214.19	208.43	213.36	206.68	200.41	216.14	210.21	204.59	217.74	209.10	201.12	221.60	213.84	206.61	211.0	225	94	104
7	1218	854.51	828.50	804.02	831.13	797.29	766.10	838.26	825.02	812.20	816.38	788.59	762.64	809.45	779.53	751.74	804.4	675	119	
7	1229	706.20	699.40	692.72	715.92	686.64	659.65	726.92	720.40	714.01	732.87	722.18	711.79	764.66	744.76	725.87	714.9	675	106	
7	1235	665.20	641.20	618.87	632.57	600.64	571.78	648.45	661.59	675.26	661.63	624.45	591.23	627.37	604.04	582.38	627.1	675	93	
7	1237	873.37	830.08	790.87	832.60	812.45	793.25	843.67	808.43	776.02	768.01	731.39	698.11	730.28	694.02	661.19	776.2	675	115	
7	1254	663.18	650.30	637.91	664.78	642.52	621.70	667.93	646.05	625.56	636.12	621.25	607.05	659.01	648.35	638.03	642.0	675	95	106

TABLE A - 3 RAW AND ADJUSTED BLOOD LEAD DATA

PHASE II EXPERIMENT 12

pig number	sample	group	material administered	dosage	qualifier	result	day	source file	MATRIX	Adjusted Value (ug/dL)[a]
1205	8-912-0143	1	Control	0	<	1	-4	T960525B	BLOOD	0.5
1228	8-912-0155	1	Control	0	<	1	-4	T960525B	BLOOD	0.5
1236	8-912-0138	1	Control	0	<	1	-4	T960525B	BLOOD	0.5
1208	8-912-0126	2	PbAc	25	<	1	-4	T960525B	BLOOD	0.5
1213	8-912-0156	2	PbAc	25	<	1	-4	T960525B	BLOOD	0.5
1215	8-912-0135	2	PbAc	25	<	1	-4	T960525B	BLOOD	0.5
1217	8-912-0146	2	PbAc	25	<	1	-4	T960525B	BLOOD	0.5
1248	8-912-0132	2	PbAc	25	<	1	-4	T960525B	BLOOD	0.5
1227	8-912-0124	3	PbAc	75	<	1	-4	T960525B	BLOOD	0.5
1240	8-912-0141	3	PbAc	75	<	1	-4	T960525B	BLOOD	0.5
1243	8-912-0172	3	PbAc	75	<	1	-4	T960525B	BLOOD	0.5
1244	8-912-0150	3	PbAc	75	<	1	-4	T960525B	BLOOD	0.5
1255	8-912-0129	3	PbAc	75	<	1	-4	T960525B	BLOOD	0.5
1222	8-912-0166	4	PbAc	225	<	1	-4	T960525B	BLOOD	0.5
1225	8-912-0122	4	PbAc	225	<	1	-4	T960525B	BLOOD	0.5
1226	8-912-0134	4	PbAc	225	<	1	-4	T960525B	BLOOD	0.5
1241	8-912-0140	4	PbAc	225	<	1	-4	T960525B	BLOOD	0.5
1249	8-912-0165	4	PbAc	225	<	1	-4	T960525B	BLOOD	0.5
1201	8-912-0173	5	Galena	75	<	1	-4	T960525B	BLOOD	0.5
1233	8-912-0145	5	Galena	75	<	1	-4	T960525B	BLOOD	0.5
1250	8-912-0158	5	Galena	75	<	1	-4	T960525B	BLOOD	0.5
1251	8-912-0151	5	Galena	75	<	1	-4	T960525B	BLOOD	0.5
1253	8-912-0164	5	Galena	75	<	1	-4	T960525B	BLOOD	0.5
1203	8-912-0176	6	Galena	225	<	1	-4	T960525B	BLOOD	0.5
1209	8-912-0153	6	Galena	225	<	1	-4	T960525B	BLOOD	0.5
1214	8-912-0174	6	Galena	225	<	1	-4	T960525B	BLOOD	0.5
1231	8-912-0130	6	Galena	225	<	1	-4	T960525B	BLOOD	0.5
1247	8-912-0168	6	Galena	225	<	1	-4	T960525B	BLOOD	0.5
1218	8-912-0128	7	Galena	675	<	1	-4	T960525B	BLOOD	0.5
1229	8-912-0157	7	Galena	675	<	1	-4	T960525B	BLOOD	0.5
1235	8-912-0144	7	Galena	675	<	1	-4	T960525B	BLOOD	0.5
1237	8-912-0162	7	Galena	675	<	1	-4	T960525B	BLOOD	0.5
1254	8-912-0169	7	Galena	675	<	1	-4	T960525B	BLOOD	0.5
1205	8-912-0211	1	Control	0	<	1	0	T960525B	BLOOD	0.5
1228	8-912-0199	1	Control	0	<	1	0	T960525B	BLOOD	0.5
1236	8-912-0229	1	Control	0	<	1	0	T960525B	BLOOD	0.5
1208	8-912-0207	2	PbAc	25	<	1	0	T960525B	BLOOD	0.5
1213	8-912-0218	2	PbAc	25	<	1	0	T960525B	BLOOD	0.5
1215	8-912-0187	2	PbAc	25	<	1	0	T960525B	BLOOD	0.5
1217	8-912-0222	2	PbAc	25	<	1	0	T960525B	BLOOD	0.5
1248	8-912-0202	2	PbAc	25	<	1	0	T960525B	BLOOD	0.5
1227	8-912-0181	3	PbAc	75	<	1	0	T960525B	BLOOD	0.5
1240	8-912-0220	3	PbAc	75	<	1	0	T960525B	BLOOD	0.5
1243	8-912-0194	3	PbAc	75	<	1	0	T960525B	BLOOD	0.5
1244	8-912-0185	3	PbAc	75	<	1	0	T960525B	BLOOD	0.5
1255	8-912-0204	3	PbAc	75	<	1	0	T960525B	BLOOD	0.5
1222	8-912-0215	4	PbAc	225	<	1	0	T960525B	BLOOD	0.5
1225	8-912-0209	4	PbAc	225	<	1	0	T960525B	BLOOD	0.5
1226	8-912-0227	4	PbAc	225	<	1	0	T960525B	BLOOD	0.5
1241	8-912-0192	4	PbAc	225	<	1	0	T960525B	BLOOD	0.5
1249	8-912-0219	4	PbAc	225	<	1	0	T960525B	BLOOD	0.5
1201	8-912-0208	5	Galena	75	<	1	0	T960525B	BLOOD	0.5
1233	8-912-0225	5	Galena	75	<	1	0	T960525B	BLOOD	0.5
1250	8-912-0188	5	Galena	75	<	1	0	T960525B	BLOOD	0.5
1251	8-912-0206	5	Galena	75	<	1	0	T960525B	BLOOD	0.5
1253	8-912-0177	5	Galena	75	<	1	0	T960525B	BLOOD	0.5
1203	8-912-0216	6	Galena	225	<	1	0	T960525B	BLOOD	0.5
1209	8-912-0198	6	Galena	225	<	1	0	T960525B	BLOOD	0.5
1214	8-912-0205	6	Galena	225	<	1	0	T960525B	BLOOD	0.5
1231	8-912-0233	6	Galena	225	<	1	0	T960525B	BLOOD	0.5
1247	8-912-0201	6	Galena	225	<	1	0	T960525B	BLOOD	0.5
1218	8-912-0183	7	Galena	675	<	1	0	T960525B	BLOOD	0.5
1229	8-912-0196	7	Galena	675	<	1	0	T960525B	BLOOD	0.5
1235	8-912-0221	7	Galena	675	<	1	0	T960525B	BLOOD	0.5
1237	8-912-0193	7	Galena	675	<	1	0	T960525B	BLOOD	0.5
1254	8-912-0180	7	Galena	675	<	1	0	T960525B	BLOOD	0.5
1205	8-912-0250	1	Control	0	<	1	1	T960610B	BLOOD	0.5
1228	8-912-0280	1	Control	0	<	1	1	T960610B	BLOOD	0.5
1236	8-912-0288	1	Control	0	<	1	1	T960610B	BLOOD	0.5
1208	8-912-0268	2	PbAc	25	<	1	1	T960610B	BLOOD	0.5

pig number	sample	group	material administered	dosage	qualifier	result	day	source file	MATRIX	Adjusted Value (ug/dL)[a]
1213	8-912-0285	2	PbAc	25		1.3	1	T960610B	BLOOD	1.3
1215	8-912-0287	2	PbAc	25	<	1	1	T960610B	BLOOD	0.5
1217	8-912-0257	2	PbAc	25	<	1	1	T960610B	BLOOD	0.5
1248	8-912-0267	2	PbAc	25	<	1	1	T960610B	BLOOD	0.5
1227	8-912-0259	3	PbAc	75	<	1	1	T960610B	BLOOD	0.5
1240	8-912-0270	3	PbAc	75		2.2	1	T960610B	BLOOD	2.2
1243	8-912-0244	3	PbAc	75	<	1	1	T960610B	BLOOD	0.5
1244	8-912-0274	3	PbAc	75		1.6	1	T960610B	BLOOD	1.6
1255	8-912-0249	3	PbAc	75		1	1	T960610B	BLOOD	1
1222	8-912-0253	4	PbAc	225		1.9	1	T960610B	BLOOD	1.9
1225	8-912-0258	4	PbAc	225		2.5	1	T960610B	BLOOD	2.5
1226	8-912-0264	4	PbAc	225		1.2	1	T960610B	BLOOD	1.2
1241	8-912-0269	4	PbAc	225		3.8	1	T960610B	BLOOD	3.8
1249	8-912-0242	4	PbAc	225		2.1	1	T960610B	BLOOD	2.1
1201	8-912-0240	5	Galena	75	<	1	1	T960610B	BLOOD	0.5
1233	8-912-0261	5	Galena	75	<	1	1	T960610B	BLOOD	0.5
1250	8-912-0238	5	Galena	75	<	1	1	T960610B	BLOOD	0.5
1251	8-912-0256	5	Galena	75	<	1	1	T960610B	BLOOD	0.5
1253	8-912-0251	5	Galena	75	<	1	1	T960610B	BLOOD	0.5
1203	8-912-0289	6	Galena	225	<	1	1	T960610B	BLOOD	0.5
1209	8-912-0282	6	Galena	225	<	1	1	T960610B	BLOOD	0.5
1214	8-912-0262	6	Galena	225	<	1	1	T960610B	BLOOD	0.5
1231	8-912-0241	6	Galena	225	<	1	1	T960610B	BLOOD	0.5
1247	8-912-0243	6	Galena	225	<	1	1	T960610B	BLOOD	0.5
1218	8-912-0263	7	Galena	675	<	1	1	T960610B	BLOOD	0.5
1229	8-912-0235	7	Galena	675	<	1	1	T960610B	BLOOD	0.5
1235	8-912-0255	7	Galena	675	<	1	1	T960610B	BLOOD	0.5
1237	8-912-0254	7	Galena	675	<	1	1	T960610B	BLOOD	0.5
1254	8-912-0275	7	Galena	675		1	1	T960610B	BLOOD	1
1205	8-912-0333	1	Control	0		1.5	2	T960610B	BLOOD	1.5
1228	8-912-0317	1	Control	0	<	1	2	T960610B	BLOOD	0.5
1236	8-912-0295	1	Control	0	<	1	2	T960610B	BLOOD	0.5
1208	8-912-0306	2	PbAc	25	<	1	2	T960610B	BLOOD	0.5
1213	8-912-0297	2	PbAc	25		1.4	2	T960610B	BLOOD	1.4
1215	8-912-0346	2	PbAc	25		2	2	T960610B	BLOOD	2
1217	8-912-0318	2	PbAc	25	<	1	2	T960610B	BLOOD	0.5
1248	8-912-0339	2	PbAc	25	<	1	2	T960610B	BLOOD	0.5
1227	8-912-0304	3	PbAc	75		1.2	2	T960610B	BLOOD	1.2
1240	8-912-0342	3	PbAc	75		3.2	2	T960610B	BLOOD	3.2
1243	8-912-0321	3	PbAc	75		1.2	2	T960610B	BLOOD	1.2
1244	8-912-0313	3	PbAc	75		1.9	2	T960610B	BLOOD	1.9
1255	8-912-0308	3	PbAc	75		2.8	2	T960610B	BLOOD	2.8
1222	8-912-0320	4	PbAc	225		5.3	2	T960610B	BLOOD	5.3
1225	8-912-0298	4	PbAc	225		6	2	T960610B	BLOOD	6
1226	8-912-0338	4	PbAc	225		3.1	2	T960610B	BLOOD	3.1
1241	8-912-0312	4	PbAc	225		5.3	2	T960610B	BLOOD	5.3
1249	8-912-0301	4	PbAc	225		5.2	2	T960610B	BLOOD	5.2
1201	8-912-0341	5	Galena	75	<	1	2	T960610B	BLOOD	0.5
1233	8-912-0328	5	Galena	75	<	1	2	T960610B	BLOOD	0.5
1250	8-912-0323	5	Galena	75	<	1	2	T960610B	BLOOD	0.5
1251	8-912-0314	5	Galena	75	<	1	2	T960610B	BLOOD	0.5
1253	8-912-0315	5	Galena	75	<	1	2	T960610B	BLOOD	0.5
1203	8-912-0311	6	Galena	225	<	1	2	T960610B	BLOOD	0.5
1209	8-912-0299	6	Galena	225	<	1	2	T960610B	BLOOD	0.5
1214	8-912-0344	6	Galena	225	<	1	2	T960610B	BLOOD	0.5
1231	8-912-0324	6	Galena	225	<	1	2	T960610B	BLOOD	0.5
1247	8-912-0302	6	Galena	225	<	1	2	T960610B	BLOOD	0.5
1218	8-912-0300	7	Galena	675	<	1	2	T960610B	BLOOD	0.5
1229	8-912-0337	7	Galena	675	<	1	2	T960610B	BLOOD	0.5
1235	8-912-0310	7	Galena	675	<	1	2	T960610B	BLOOD	0.5
1237	8-912-0347	7	Galena	675	<	1	2	T960610B	BLOOD	0.5
1254	8-912-0335	7	Galena	675		1.1	2	T960610B	BLOOD	1.1
1205	8-912-0360	1	Control	0	<	1	3	T960610B	BLOOD	0.5
1228	8-912-0361	1	Control	0	<	1	3	T960610B	BLOOD	0.5
1236	8-912-0381	1	Control	0	<	1	3	T960610B	BLOOD	0.5
1208	8-912-0383	2	PbAc	25		1.1	3	T960610B	BLOOD	1.1
1213	8-912-0349	2	PbAc	25		2.4	3	T960610B	BLOOD	2.4
1215	8-912-0365	2	PbAc	25		1.9	3	T960610B	BLOOD	1.9
1217	8-912-0378	2	PbAc	25	<	1	3	T960610B	BLOOD	0.5
1248	8-912-0400	2	PbAc	25		1.2	3	T960610B	BLOOD	1.2
1227	8-912-0382	3	PbAc	75		3.1	3	T960610B	BLOOD	3.1
1240	8-912-0364	3	PbAc	75		3.6	3	T960610B	BLOOD	3.6
1243	8-912-0386	3	PbAc	75		3	3	T960610B	BLOOD	3
1244	8-912-0374	3	PbAc	75		2.2	3	T960610B	BLOOD	2.2
1255	8-912-0363	3	PbAc	75		4.1	3	T960610B	BLOOD	4.1

pig number	sample	group	material administered	dosage	qualifier	result	day	source file	MATRIX	Adjusted Value (ug/dL)[a]
1222	8-912-0397	4	PbAc	225		6.4	3	T960610B	BLOOD	6.4
1225	8-912-0351	4	PbAc	225		6.8	3	T960610B	BLOOD	6.8
1226	8-912-0354	4	PbAc	225		3.9	3	T960610B	BLOOD	3.9
1241	8-912-0348	4	PbAc	225		7.8	3	T960610B	BLOOD	7.8
1249	8-912-0373	4	PbAc	225		5.5	3	T960610B	BLOOD	5.5
1201	8-912-0369	5	Galena	75	<	1	3	T960610B	BLOOD	0.5
1233	8-912-0390	5	Galena	75	<	1	3	T960610B	BLOOD	0.5
1250	8-912-0377	5	Galena	75	<	1	3	T960610B	BLOOD	0.5
1251	8-912-0380	5	Galena	75	<	1	3	T960610B	BLOOD	0.5
1253	8-912-0393	5	Galena	75		1.3	3	T960610B	BLOOD	1.3
1203	8-912-0399	6	Galena	225	<	1	3	T960610B	BLOOD	0.5
1209	8-912-0403	6	Galena	225	<	1	3	T960610B	BLOOD	0.5
1214	8-912-0366	6	Galena	225	<	1	3	T960610B	BLOOD	0.5
1231	8-912-0395	6	Galena	225		1.2	3	T960610B	BLOOD	1.2
1247	8-912-0376	6	Galena	225	<	1	3	T960610B	BLOOD	0.5
1218	8-912-0384	7	Galena	675	<	1	3	T960610B	BLOOD	0.5
1229	8-912-0352	7	Galena	675		1.3	3	T960610B	BLOOD	1.3
1235	8-912-0389	7	Galena	675	<	1	3	T960610B	BLOOD	0.5
1237	8-912-0391	7	Galena	675	<	1	3	T960610B	BLOOD	0.5
1254	8-912-0392	7	Galena	675		1.4	3	T960610B	BLOOD	1.4
1205	8-912-0434	1	Control	0	<	1	5	T960610B	BLOOD	0.5
1228	8-912-0446	1	Control	0	<	1	5	T960610B	BLOOD	0.5
1236	8-912-0445	1	Control	0	<	1	5	T960610B	BLOOD	0.5
1208	8-912-0415	2	PbAc	25		1.2	5	T960610B	BLOOD	1.2
1213	8-912-0432	2	PbAc	25		1	5	T960610B	BLOOD	1
1215	8-912-0423	2	PbAc	25		2.3	5	T960610B	BLOOD	2.3
1217	8-912-0442	2	PbAc	25	<	1	5	T960610B	BLOOD	0.5
1248	8-912-0429	2	PbAc	25		1	5	T960610B	BLOOD	1
1227	8-912-0414	3	PbAc	75		4.7	5	T960610B	BLOOD	4.7
1240	8-912-0406	3	PbAc	75		4.9	5	T960610B	BLOOD	4.9
1243	8-912-0457	3	PbAc	75		3.9	5	T960610B	BLOOD	3.9
1244	8-912-0416	3	PbAc	75		4.9	5	T960610B	BLOOD	4.9
1255	8-912-0407	3	PbAc	75		4.9	5	T960610B	BLOOD	4.9
1222	8-912-0449	4	PbAc	225		8.9	5	T960610B	BLOOD	8.9
1225	8-912-0453	4	PbAc	225		6.1	5	T960610B	BLOOD	6.1
1226	8-912-0421	4	PbAc	225		6.2	5	T960610B	BLOOD	6.2
1241	8-912-0409	4	PbAc	225		7.7	5	T960610B	BLOOD	7.7
1249	8-912-0461	4	PbAc	225		10.1	5	T960610B	BLOOD	10.1
1201	8-912-0433	5	Galena	75	<	1	5	T960610B	BLOOD	0.5
1233	8-912-0458	5	Galena	75	<	1	5	T960610B	BLOOD	0.5
1250	8-912-0443	5	Galena	75	<	1	5	T960610B	BLOOD	0.5
1251	8-912-0460	5	Galena	75	<	1	5	T960610B	BLOOD	0.5
1253	8-912-0426	5	Galena	75	<	1	5	T960610B	BLOOD	0.5
1203	8-912-0422	6	Galena	225	<	1	5	T960610B	BLOOD	0.5
1209	8-912-0437	6	Galena	225	<	1	5	T960610B	BLOOD	0.5
1214	8-912-0444	6	Galena	225	<	1	5	T960610B	BLOOD	0.5
1231	8-912-0419	6	Galena	225	<	1	5	T960610B	BLOOD	0.5
1247	8-912-0425	6	Galena	225	<	1	5	T960610B	BLOOD	0.5
1218	8-912-0456	7	Galena	675	<	1	5	T960610B	BLOOD	0.5
1229	8-912-0408	7	Galena	675	<	1	5	T960610B	BLOOD	0.5
1235	8-912-0459	7	Galena	675	<	1	5	T960610B	BLOOD	0.5
1237	8-912-0424	7	Galena	675	<	1	5	T960610B	BLOOD	0.5
1254	8-912-0417	7	Galena	675	<	1	5	T960610B	BLOOD	0.5
1205	8-912-0515	1	Control	0	<	1	7	T960617B	BLOOD	0.5
1228	8-912-0512	1	Control	0	<	1	7	T960617B	BLOOD	0.5
1236	8-912-0518	1	Control	0		1.1	7	T960617B	BLOOD	1.1
1208	8-912-0481	2	PbAc	25	<	1	7	T960610B	BLOOD	0.5
1213	8-912-0467	2	PbAc	25		1.2	7	T960610B	BLOOD	1.2
1215	8-912-0507	2	PbAc	25		2.7	7	T960617B	BLOOD	2.7
1217	8-912-0487	2	PbAc	25		1.1	7	T960617B	BLOOD	1.1
1248	8-912-0478	2	PbAc	25		1.8	7	T960610B	BLOOD	1.8
1227	8-912-0517	3	PbAc	75		2.7	7	T960617B	BLOOD	2.7
1240	8-912-0488	3	PbAc	75		4.9	7	T960617B	BLOOD	4.9
1243	8-912-0490	3	PbAc	75		5.1	7	T960617B	BLOOD	5.1
1244	8-912-0509	3	PbAc	75		4.2	7	T960617B	BLOOD	4.2
1255	8-912-0516	3	PbAc	75		4.5	7	T960617B	BLOOD	4.5
1222	8-912-0503	4	PbAc	225		8.3	7	T960617B	BLOOD	8.3
1225	8-912-0506	4	PbAc	225		7.6	7	T960617B	BLOOD	7.6
1226	8-912-0491	4	PbAc	225		9.7	7	T960617B	BLOOD	9.7
1241	8-912-0497	4	PbAc	225		11.2	7	T960617B	BLOOD	11.2
1249	8-912-0470	4	PbAc	225		8.6	7	T960610B	BLOOD	8.6
1201	8-912-0484	5	Galena	75	<	1	7	T960617B	BLOOD	0.5
1233	8-912-0475	5	Galena	75	<	1	7	T960610B	BLOOD	0.5
1250	8-912-0492	5	Galena	75		1.1	7	T960617B	BLOOD	1.1
1251	8-912-0462	5	Galena	75	<	1	7	T960610B	BLOOD	0.5

pig number	sample	group	material administered	dosage	qualifier	result	day	source file	MATRIX	Adjusted Value (ug/dL)[a]
1253	8-912-0504	5	Galena	75	<	1	7	T960617B	BLOOD	0.5
1203	8-912-0499	6	Galena	225		1.1	7	T960617B	BLOOD	1.1
1209	8-912-0466	6	Galena	225	<	1	7	T960610B	BLOOD	0.5
1214	8-912-0508	6	Galena	225	<	1	7	T960617B	BLOOD	0.5
1231	8-912-0468	6	Galena	225	<	1	7	T960610B	BLOOD	0.5
1247	8-912-0476	6	Galena	225	<	1	7	T960610B	BLOOD	0.5
1218	8-912-0496	7	Galena	675		1	7	T960617B	BLOOD	1
1229	8-912-0514	7	Galena	675		1.3	7	T960617B	BLOOD	1.3
1235	8-912-0510	7	Galena	675	<	1	7	T960617B	BLOOD	0.5
1237	8-912-0500	7	Galena	675	<	1	7	T960617B	BLOOD	0.5
1254	8-912-0489	7	Galena	675		1.7	7	T960617B	BLOOD	1.7
1205	8-912-0539	1	Control	0	<	1	9	T960617B	BLOOD	0.5
1228	8-912-0541	1	Control	0	<	1	9	T960617B	BLOOD	0.5
1236	8-912-0570	1	Control	0	<	1	9	T960617B	BLOOD	0.5
1208	8-912-0558	2	PbAc	25		2.2	9	T960617B	BLOOD	2.2
1213	8-912-0562	2	PbAc	25		1.8	9	T960617B	BLOOD	1.8
1215	8-912-0544	2	PbAc	25		2.4	9	T960617B	BLOOD	2.4
1217	8-912-0545	2	PbAc	25	<	1	9	T960617B	BLOOD	0.5
1248	8-912-0547	2	PbAc	25		2.5	9	T960617B	BLOOD	2.5
1227	8-912-0529	3	PbAc	75		2	9	T960617B	BLOOD	2
1240	8-912-0537	3	PbAc	75		6.2	9	T960617B	BLOOD	6.2
1243	8-912-0560	3	PbAc	75		4.7	9	T960617B	BLOOD	4.7
1244	8-912-0540	3	PbAc	75		3.2	9	T960617B	BLOOD	3.2
1255	8-912-0554	3	PbAc	75		5.3	9	T960617B	BLOOD	5.3
1222	8-912-0553	4	PbAc	225		8.7	9	T960617B	BLOOD	8.7
1225	8-912-0575	4	PbAc	225		7.6	9	T960617B	BLOOD	7.6
1226	8-912-0520	4	PbAc	225		9.1	9	T960617B	BLOOD	9.1
1241	8-912-0557	4	PbAc	225		9	9	T960617B	BLOOD	9
1249	8-912-0568	4	PbAc	225		8.8	9	T960617B	BLOOD	8.8
1201	8-912-0571	5	Galena	75	<	1	9	T960617B	BLOOD	0.5
1233	8-912-0531	5	Galena	75	<	1	9	T960617B	BLOOD	0.5
1250	8-912-0573	5	Galena	75	<	1	9	T960617B	BLOOD	0.5
1251	8-912-0567	5	Galena	75	<	1	9	T960617B	BLOOD	0.5
1253	8-912-0563	5	Galena	75		1.1	9	T960617B	BLOOD	1.1
1203	8-912-0564	6	Galena	225	<	1	9	T960617B	BLOOD	0.5
1209	8-912-0550	6	Galena	225	<	1	9	T960617B	BLOOD	0.5
1214	8-912-0574	6	Galena	225		1.2	9	T960617B	BLOOD	1.2
1231	8-912-0572	6	Galena	225	<	1	9	T960617B	BLOOD	0.5
1247	8-912-0526	6	Galena	225	<	1	9	T960617B	BLOOD	0.5
1218	8-912-0552	7	Galena	675	<	1	9	T960617B	BLOOD	0.5
1229	8-912-0566	7	Galena	675		1.2	9	T960617B	BLOOD	1.2
1235	8-912-0535	7	Galena	675	<	1	9	T960617B	BLOOD	0.5
1237	8-912-0549	7	Galena	675	<	1	9	T960617B	BLOOD	0.5
1254	8-912-0524	7	Galena	675	<	1	9	T960617B	BLOOD	0.5
1205	8-912-0585	1	Control	0	<	1	12	T960622B	BLOOD	0.5
1228	8-912-0616	1	Control	0	<	1	12	T960622B	BLOOD	0.5
1236	8-912-0603	1	Control	0	<	1	12	T960622B	BLOOD	0.5
1208	8-912-0627	2	PbAc	25		1.7	12	T960622B	BLOOD	1.7
1213	8-912-0628	2	PbAc	25		2.6	12	T960622B	BLOOD	2.6
1215	8-912-0612	2	PbAc	25		2.3	12	T960622B	BLOOD	2.3
1217	8-912-0605	2	PbAc	25		1.4	12	T960622B	BLOOD	1.4
1248	8-912-0619	2	PbAc	25		2.6	12	T960622B	BLOOD	2.6
1227	8-912-0602	3	PbAc	75		2.7	12	T960622B	BLOOD	2.7
1240	8-912-0623	3	PbAc	75		5.4	12	T960622B	BLOOD	5.4
1243	8-912-0590	3	PbAc	75		3.3	12	T960622B	BLOOD	3.3
1244	8-912-0595	3	PbAc	75		3.7	12	T960622B	BLOOD	3.7
1255	8-912-0610	3	PbAc	75		5	12	T960622B	BLOOD	5
1222	8-912-0631	4	PbAc	225		8	12	T960622B	BLOOD	8
1225	8-912-0578	4	PbAc	225		10.4	12	T960617B	BLOOD	10.4
1226	8-912-0608	4	PbAc	225		7.9	12	T960622B	BLOOD	7.9
1241	8-912-0622	4	PbAc	225		10.8	12	T960622B	BLOOD	10.8
1249	8-912-0614	4	PbAc	225		8.8	12	T960622B	BLOOD	8.8
1201	8-912-0615	5	Galena	75	<	1	12	T960622B	BLOOD	0.5
1233	8-912-0594	5	Galena	75	<	1	12	T960622B	BLOOD	0.5
1250	8-912-0591	5	Galena	75	<	1	12	T960622B	BLOOD	0.5
1251	8-912-0584	5	Galena	75	<	1	12	T960622B	BLOOD	0.5
1253	8-912-0579	5	Galena	75	<	1	12	T960617B	BLOOD	0.5
1203	8-912-0577	6	Galena	225		1.2	12	T960617B	BLOOD	1.2
1209	8-912-0583	6	Galena	225	<	1	12	T960622B	BLOOD	0.5
1214	8-912-0607	6	Galena	225	<	1	12	T960622B	BLOOD	0.5
1231	8-912-0609	6	Galena	225	<	1	12	T960622B	BLOOD	0.5
1247	8-912-0601	6	Galena	225	<	1	12	T960622B	BLOOD	0.5
1218	8-912-0621	7	Galena	675		1.2	12	T960622B	BLOOD	1.2
1229	8-912-0597	7	Galena	675	<	1	12	T960622B	BLOOD	0.5
1235	8-912-0592	7	Galena	675	<	1	12	T960622B	BLOOD	0.5

pig number	sample	group	material administered	dosage	qualifier	result	day	source file	MATRIX	Adjusted Value (ug/dL)[a]
1237	8-912-0600	7	Galena	675	<	1	12	T960622B	BLOOD	0.5
1254	8-912-0599	7	Galena	675	<	1	12	T960622B	BLOOD	0.5
1205	8-912-0663	1	Control	0	<	1	15	T960622B	BLOOD	0.5
1228	8-912-0679	1	Control	0		1	15	T960622B	BLOOD	1
1236	8-912-0649	1	Control	0	<	1	15	T960622B	BLOOD	0.5
1208	8-912-0674	2	PbAc	25		1.9	15	T960622B	BLOOD	1.9
1213	8-912-0670	2	PbAc	25		3.1	15	T960622B	BLOOD	3.1
1215	8-912-0642	2	PbAc	25		1.3	15	T960622B	BLOOD	1.3
1217	8-912-0677	2	PbAc	25		2.5	15	T960622B	BLOOD	2.5
1248	8-912-0661	2	PbAc	25		1.9	15	T960622B	BLOOD	1.9
1227	8-912-0643	3	PbAc	75		2.3	15	T960622B	BLOOD	2.3
1240	8-912-0660	3	PbAc	75		5.5	15	T960622B	BLOOD	5.5
1243	8-912-0684	3	PbAc	75		6	15	T960622B	BLOOD	6
1244	8-912-0680	3	PbAc	75		6.3	15	T960622B	BLOOD	6.3
1255	8-912-0676	3	PbAc	75		5.3	15	T960622B	BLOOD	5.3
1222	8-912-0650	4	PbAc	225		8.8	15	T960622B	BLOOD	8.8
1225	8-912-0634	4	PbAc	225		8.4	15	T960622B	BLOOD	8.4
1226	8-912-0656	4	PbAc	225		10.1	15	T960622B	BLOOD	10.1
1241	8-912-0633	4	PbAc	225		9.4	15	T960622B	BLOOD	9.4
1249	8-912-0636	4	PbAc	225		5.2	15	T960622B	BLOOD	5.2
1201	8-912-0639	5	Galena	75	<	1	15	T960622B	BLOOD	0.5
1233	8-912-0659	5	Galena	75	<	1	15	T960622B	BLOOD	0.5
1250	8-912-0687	5	Galena	75	<	1	15	T960622B	BLOOD	0.5
1251	8-912-0648	5	Galena	75	<	1	15	T960622B	BLOOD	0.5
1253	8-912-0686	5	Galena	75	<	1	15	T960622B	BLOOD	0.5
1203	8-912-0644	6	Galena	225	<	1	15	T960622B	BLOOD	0.5
1209	8-912-0689	6	Galena	225		3.7	15	T960622B	BLOOD	3.7
1214	8-912-0678	6	Galena	225	<	1	15	T960622B	BLOOD	0.5
1231	8-912-0657	6	Galena	225	<	1	15	T960622B	BLOOD	0.5
1247	8-912-0635	6	Galena	225	<	1	15	T960622B	BLOOD	0.5
1218	8-912-0665	7	Galena	675		2.9	15	T960622B	BLOOD	2.9
1229	8-912-0645	7	Galena	675	<	1	15	T960622B	BLOOD	0.5
1235	8-912-0658	7	Galena	675	<	1	15	T960622B	BLOOD	0.5
1237	8-912-0675	7	Galena	675		1	15	T960622B	BLOOD	1
1254	8-912-0667	7	Galena	675		1.1	15	T960622B	BLOOD	1.1

a Non-detects evaluated using 1/2 the quantitation limit; laboratory results (ug/L) converted to concentration in blood (ug/dL) by dividing by dilution factor of

TABLE A-4 BLOOD LEAD OUTLIERS

Flagged Data Points
Outliers

test material	target dosage	Actual Dose*	group	pig#	BLOOD LEAD (ug/dL) BY DAY									
					-4	0	1	2	3	5	7	9	12	15
Control	0	0.00	1	1205	0.5	0.5	0.5	1.5	0.5	0.5	0.5	0.5	0.5	0.5
Control	0	0.00	1	1228	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1
Control	0	0.00	1	1236	0.5	0.5	0.5	0.5	0.5	0.5	1.1	0.5	0.5	0.5
PbAc	25	22.41	2	1208	0.5	0.5	0.5	0.5	1.1	1.2	0.5	2.2	1.7	1.9
PbAc	25	33.23	2	1213	0.5	0.5	1.3	1.4	2.4	1	1.2	1.8	2.6	3.1
PbAc	25	22.98	2	1215	0.5	0.5	0.5	2	1.9	2.3	2.7	2.4	2.3	1.3
PbAc	25	34.30	2	1217	0.5	0.5	0.5	0.5	0.5	0.5	1.1	0.5	1.4	2.5
PbAc	25	23.09	2	1248	0.5	0.5	0.5	0.5	1.2	1	1.8	2.5	2.6	1.9
PbAc	75	69.36	3	1227	0.5	0.5	0.5	1.2	3.1	4.7	2.7	2	2.7	2.3
PbAc	75	80.22	3	1240	0.5	0.5	2.2	3.2	3.6	4.9	4.9	6.2	5.4	5.5
PbAc	75	80.12	3	1243	0.5	0.5	0.5	1.2	3	3.9	5.1	4.7	3.3	6
PbAc	75	72.73	3	1244	0.5	0.5	1.6	1.9	2.2	4.9	4.2	3.2	3.7	6.3
PbAc	75	86.17	3	1255	0.5	0.5	1	2.8	4.1	4.9	4.5	5.3	5	5.3
PbAc	225	261.26	4	1222	0.5	0.5	1.9	5.3	6.4	8.9	8.3	8.7	8	8.8
PbAc	225	271.00	4	1225	0.5	0.5	2.5	6	6.8	6.1	7.6	7.6	10.4	8.4
PbAc	225	254.18	4	1226	0.5	0.5	1.2	3.1	3.9	6.2	9.7	9.1	7.9	10.1
PbAc	225	215.60	4	1241	0.5	0.5	3.8	5.3	7.8	7.7	11.2	9	10.8	9.4
PbAc	225	193.84	4	1249	0.5	0.5	2.1	5.2	5.5	10.1	8.6	8.8	8.8	5.2
Galena	75	82.08	5	1201	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Galena	75	84.49	5	1233	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Galena	75	87.39	5	1250	0.5	0.5	0.5	0.5	0.5	0.5	1.1	0.5	0.5	0.5
Galena	75	68.28	5	1251	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Galena	75	70.57	5	1253	0.5	0.5	0.5	0.5	1.3	0.5	0.5	1.1	0.5	0.5
Galena	225	252.65	6	1203	0.5	0.5	0.5	0.5	0.5	0.5	1.1	0.5	1.2	0.5
Galena	225	252.87	6	1209	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	3.7
Galena	225	220.06	6	1214	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.2	0.5	0.5
Galena	225	232.36	6	1231	0.5	0.5	0.5	0.5	1.2	0.5	0.5	0.5	0.5	0.5
Galena	225	210.95	6	1247	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Galena	675	804.36	7	1218	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	1.2	2.9
Galena	675	714.93	7	1229	0.5	0.5	0.5	0.5	1.3	0.5	1.3	1.2	0.5	0.5
Galena	675	627.11	7	1235	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Galena	675	776.25	7	1237	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1
Galena	675	641.98	7	1254	0.5	0.5	1	1.1	1.4	0.5	1.7	0.5	0.5	1.1

*** Average Time and Weight-Adjusted Dose for Each Pig**

TABLE A-5 RATIONALE FOR PbB OUTLIER DECISIONS

Pig #1209 - Day 15 - Group 6: Value of 3.7 was treated as an outlier based on individual animal response and group responses which were much lower (BDL). This value was replaced with a value of 0.5

TABLE A-6 Area Under Curve Determinations

Calculated using interpolated values for missing or excluded data

		AUC (ug/dL-days) For Time Span Shown								AUC Total
group	pig#	0-1	1-2	2-3	3-5	5-7	7-9	9-12	12-15	(ug/dL-days)
1	1205	0.50	1.00	1.00	1.00	1.00	1.00	1.50	1.50	8.50
1	1228	0.50	0.50	0.50	1.00	1.00	1.00	1.50	2.25	8.25
1	1236	0.50	0.50	0.50	1.00	1.60	1.60	1.50	1.50	8.70
2	1208	0.50	0.50	0.80	2.30	1.70	2.70	5.85	5.40	19.75
2	1213	0.90	1.35	1.90	3.40	2.20	3.00	6.60	8.55	27.90
2	1215	0.50	1.25	1.95	4.20	5.00	5.10	7.05	5.40	30.45
2	1217	0.50	0.50	0.50	1.00	1.60	1.60	2.85	5.85	14.40
2	1248	0.50	0.50	0.85	2.20	2.80	4.30	7.65	6.75	25.55
3	1227	0.50	0.85	2.15	7.80	7.40	4.70	7.05	7.50	37.95
3	1240	1.35	2.70	3.40	8.50	9.80	11.10	17.40	16.35	70.60
3	1243	0.50	0.85	2.10	6.90	9.00	9.80	12.00	13.95	55.10
3	1244	1.05	1.75	2.05	7.10	9.10	7.40	10.35	15.00	53.80
3	1255	0.75	1.90	3.45	9.00	9.40	9.80	15.45	15.45	65.20
4	1222	1.20	3.60	5.85	15.30	17.20	17.00	25.05	25.20	110.40
4	1225	1.50	4.25	6.40	12.90	13.70	15.20	27.00	28.20	109.15
4	1226	0.85	2.15	3.50	10.10	15.90	18.80	25.50	27.00	103.80
4	1241	2.15	4.55	6.55	15.50	18.90	20.20	29.70	30.30	127.85
4	1249	1.30	3.65	5.35	15.60	18.70	17.40	26.40	21.00	109.40
5	1201	0.50	0.50	0.50	1.00	1.00	1.00	1.50	1.50	7.50
5	1233	0.50	0.50	0.50	1.00	1.00	1.00	1.50	1.50	7.50
5	1250	0.50	0.50	0.50	1.00	1.60	1.60	1.50	1.50	8.70
5	1251	0.50	0.50	0.50	1.00	1.00	1.00	1.50	1.50	7.50
5	1253	0.50	0.50	0.90	1.80	1.00	1.60	2.40	1.50	10.20
6	1203	0.50	0.50	0.50	1.00	1.60	1.60	2.55	2.55	10.80
6	1209	0.50	0.50	0.50	1.00	1.00	1.00	1.50	1.50	7.50
6	1214	0.50	0.50	0.50	1.00	1.00	1.70	2.55	1.50	9.25
6	1231	0.50	0.50	0.85	1.70	1.00	1.00	1.50	1.50	8.55
6	1247	0.50	0.50	0.50	1.00	1.00	1.00	1.50	1.50	7.50
7	1218	0.50	0.50	0.50	1.00	1.50	1.50	2.55	6.15	14.20
7	1229	0.50	0.50	0.90	1.80	1.80	2.50	2.55	1.50	12.05
7	1235	0.50	0.50	0.50	1.00	1.00	1.00	1.50	1.50	7.50
7	1237	0.50	0.50	0.50	1.00	1.00	1.00	1.50	2.25	8.25
7	1254	0.75	1.05	1.25	1.90	2.20	2.20	1.50	2.40	13.25

TABLE A - 7 TISSUE LEAD DATA

PHASE II EXPERIMENT 12

pig number	sample	group	material administered	dosage	qualifier	result	day	source file	MATRIX	Adjusted Value [a]
1205	8-912-0711	1	Control	0	<	2	15	T980717F	FEMUR	0.5
1228	8-912-0710	1	Control	0	<	2	15	T980717F	FEMUR	0.5
1236	8-912-0694	1	Control	0	<	2	15	T980717F	FEMUR	0.5
1208	8-912-0706	2	PbAc	25	<	2	15	T980717F	FEMUR	0.5
1213	8-912-0729	2	PbAc	25		4.1	15	T980717F	FEMUR	2.05
1215	8-912-0732	2	PbAc	25		4.6	15	T980717F	FEMUR	2.3
1217	8-912-0690	2	PbAc	25	<	2	15	T980717F	FEMUR	0.5
1248	8-912-0739	2	PbAc	25		2.3	15	T980717F	FEMUR	1.15
1227	8-912-0702	3	PbAc	75	<	2	15	T980717F	FEMUR	0.5
1240	8-912-0713	3	PbAc	75		6.5	15	T980717F	FEMUR	3.25
1243	8-912-0726	3	PbAc	75		10	15	T980717F	FEMUR	5
1244	8-912-0737	3	PbAc	75		10.5	15	T980717F	FEMUR	5.25
1255	8-912-0704	3	PbAc	75		7.1	15	T980717F	FEMUR	3.55
1222	8-912-0698	4	PbAc	225		18.6	15	T980717F	FEMUR	9.3
1225	8-912-0718	4	PbAc	225		18.2	15	T980717F	FEMUR	9.1
1226	8-912-0721	4	PbAc	225		24.1	15	T980717F	FEMUR	12.05
1241	8-912-0716	4	PbAc	225		8.7	15	T980717F	FEMUR	4.35
1249	8-912-0701	4	PbAc	225		7.5	15	T980717F	FEMUR	3.75
1201	8-912-0730	5	Galena	75		3.2	15	T980717F	FEMUR	1.6
1233	8-912-0714	5	Galena	75	<	2	15	T980717F	FEMUR	0.5
1250	8-912-0697	5	Galena	75	<	2	15	T980717F	FEMUR	0.5
1251	8-912-0731	5	Galena	75	<	2	15	T980717F	FEMUR	0.5
1253	8-912-0717	5	Galena	75	<	2	15	T980717F	FEMUR	0.5
1203	8-912-0699	6	Galena	225	<	2	15	T980717F	FEMUR	0.5
1209	8-912-0741	6	Galena	225		2.3	15	T980717F	FEMUR	1.15
1214	8-912-0715	6	Galena	225	<	2	15	T980717F	FEMUR	0.5
1231	8-912-0720	6	Galena	225	<	2	15	T980717F	FEMUR	0.5
1247	8-912-0696	6	Galena	225	<	2	15	T980717F	FEMUR	0.5
1218	8-912-0735	7	Galena	675		2.1	15	T980717F	FEMUR	1.05
1229	8-912-0724	7	Galena	675	<	2	15	T980717F	FEMUR	0.5
1235	8-912-0705	7	Galena	675	<	2	15	T980717F	FEMUR	0.5
1237	8-912-0709	7	Galena	675	<	2	15	T980717F	FEMUR	0.5
1254	8-912-0742	7	Galena	675		2.6	15	T980717F	FEMUR	1.3
1205	8-912-0829	1	Control	0	<	2	15	T960708K	KIDNEY	10
1228	8-912-0806	1	Control	0	<	2	15	T960708K	KIDNEY	10
1236	8-912-0847	1	Control	0	<	2	15	T960708K	KIDNEY	10
1208	8-912-0810	2	PbAc	25		3.1	15	T960708K	KIDNEY	31
1213	8-912-0822	2	PbAc	25		2.8	15	T960708K	KIDNEY	28
1215	8-912-0836	2	PbAc	25		5.3	15	T960708K	KIDNEY	53
1217	8-912-0808	2	PbAc	25		1.8	15	T960708K	KIDNEY	18
1248	8-912-0832	2	PbAc	25		270	15	T960708K	KIDNEY	2700
1227	8-912-0801	3	PbAc	75		10.7	15	T960708K	KIDNEY	107
1240	8-912-0835	3	PbAc	75		14.5	15	T960708K	KIDNEY	145
1243	8-912-0813	3	PbAc	75		11.7	15	T960708K	KIDNEY	117
1244	8-912-0814	3	PbAc	75		11.5	15	T960708K	KIDNEY	115
1255	8-912-0833	3	PbAc	75		12.2	15	T960708K	KIDNEY	122
1222	8-912-0819	4	PbAc	225		20.1	15	T960708K	KIDNEY	201
1225	8-912-0845	4	PbAc	225		24.9	15	T960708K	KIDNEY	249
1226	8-912-0830	4	PbAc	225		31.7	15	T960708K	KIDNEY	317
1241	8-912-0837	4	PbAc	225		26.4	15	T960708K	KIDNEY	264
1249	8-912-0848	4	PbAc	225		33.3	15	T960708K	KIDNEY	333
1201	8-912-0811	5	Galena	75	<	2	15	T960708K	KIDNEY	10
1233	8-912-0823	5	Galena	75		64.4	15	T960708K	KIDNEY	644
1250	8-912-0841	5	Galena	75	<	2	15	T960708K	KIDNEY	10
1251	8-912-0842	5	Galena	75	<	2	15	T960708K	KIDNEY	10
1253	8-912-0809	5	Galena	75	<	2	15	T960708K	KIDNEY	10
1203	8-912-0834	6	Galena	225	<	2	15	T960708K	KIDNEY	10
1209	8-912-0853	6	Galena	225	<	2	15	T960708K	KIDNEY	10
1214	8-912-0820	6	Galena	225	<	2	15	T960708K	KIDNEY	10
1231	8-912-0831	6	Galena	225	<	2	15	T960708K	KIDNEY	10
1247	8-912-0852	6	Galena	225	<	2	15	T960708K	KIDNEY	10
1218	8-912-0843	7	Galena	675	<	2	15	T960708K	KIDNEY	10
1229	8-912-0844	7	Galena	675	<	2	15	T960708K	KIDNEY	10
1235	8-912-0828	7	Galena	675		2	15	T960708K	KIDNEY	20
1237	8-912-0802	7	Galena	675		2.2	15	T960708K	KIDNEY	22
1254	8-912-0800	7	Galena	675	<	2	15	T960708K	KIDNEY	10
1205	8-912-0780	1	Control	0		2.5	15	T960625L	LIVER	25
1228	8-912-0772	1	Control	0	<	2	15	T960625L	LIVER	10
1236	8-912-0791	1	Control	0		3.2	15	T960625L	LIVER	32
1208	8-912-0752	2	PbAc	25		2.5	15	T960625L	LIVER	25

pig number	sample	group	material administered	dosage	qualifier	result	day	source file	MATRIX	Adjusted Value [a]
1213	8-912-0745	2	PbAc	25		2.3	15	T960625L	LIVER	23
1215	8-912-0799	2	PbAc	25		2.8	15	T960625L	LIVER	28
1217	8-912-0760	2	PbAc	25	<	2	15	T960625L	LIVER	10
1248	8-912-0754	2	PbAc	25		2.1	15	T960625L	LIVER	21
1227	8-912-0797	3	PbAc	75		7.4	15	T960625L	LIVER	74
1240	8-912-0773	3	PbAc	75		14.6	15	T960625L	LIVER	146
1243	8-912-0792	3	PbAc	75		9.5	15	T960625L	LIVER	95
1244	8-912-0789	3	PbAc	75		11.9	15	T960625L	LIVER	119
1255	8-912-0750	3	PbAc	75		10.3	15	T960625L	LIVER	103
1222	8-912-0769	4	PbAc	225		29.3	15	T960625L	LIVER	293
1225	8-912-0759	4	PbAc	225		22.7	15	T960625L	LIVER	227
1226	8-912-0794	4	PbAc	225		36	15	T960625L	LIVER	360
1241	8-912-0785	4	PbAc	225		22.8	15	T960625L	LIVER	228
1249	8-912-0768	4	PbAc	225		60.6	15	T960625L	LIVER	606
1201	8-912-0783	5	Galena	75	<	2	15	T960625L	LIVER	10
1233	8-912-0776	5	Galena	75	<	2	15	T960625L	LIVER	10
1250	8-912-0777	5	Galena	75		2.4	15	T960625L	LIVER	24
1251	8-912-0781	5	Galena	75	<	2	15	T960625L	LIVER	10
1253	8-912-0757	5	Galena	75	<	2	15	T960625L	LIVER	10
1203	8-912-0787	6	Galena	225	<	2	15	T960625L	LIVER	10
1209	8-912-0753	6	Galena	225	<	2	15	T960625L	LIVER	10
1214	8-912-0756	6	Galena	225	<	2	15	T960625L	LIVER	10
1231	8-912-0758	6	Galena	225	<	2	15	T960625L	LIVER	10
1247	8-912-0764	6	Galena	225	<	2	15	T960625L	LIVER	10
1218	8-912-0786	7	Galena	675		3.2	15	T960625L	LIVER	32
1229	8-912-0767	7	Galena	675	<	2	15	T960625L	LIVER	10
1235	8-912-0762	7	Galena	675		3.5	15	T960625L	LIVER	35
1237	8-912-0765	7	Galena	675	<	2	15	T960625L	LIVER	10
1254	8-912-0751	7	Galena	675		2.2	15	T960625L	LIVER	22

a Non-detects evaluated using 1/2 the quantitation limit. Laboratory results (ug/L) converted to tissue concentrations by dividing by sample dilution factors 0.1 kg/L (liver, kidney) or 2 g/L (ashed bone). Final units are ug Pb/kg wet weight (liver, kidney) or ug Pb/g ashed bone (femur)

TABLE A-8 SUMMARY OF ENDPOINT OUTLIERS

[ ] Selected Outliers

test material	target dosage	Actual Dose*	group	pig#	MEASUREMENT ENDPOINT Blood	Femur	Liver	Kidney
Control	0	0.00	1	1205	8.5	0.5	25.0	10.0
Control	0	0.00	1	1228	8.3	0.5	10.0	10.0
Control	0	0.00	1	1236	8.7	0.5	32.0	10.0
PbAc	25	22.41	2	1208	19.8	0.5	25.0	31.0
PbAc	25	33.23	2	1213	27.9	2.05	23.0	28.0
PbAc	25	22.98	2	1215	30.5	2.3	28.0	53.0
PbAc	25	34.30	2	1217	14.4	0.5	10.0	18.0
PbAc	25	23.09	2	1248	25.6	1.15	21.0	2700 a
PbAc	75	69.36	3	1227	38.0	0.5	74.0	107.0
PbAc	75	80.22	3	1240	70.6	3.25	146.0	145.0
PbAc	75	80.12	3	1243	55.1	5	95.0	117.0
PbAc	75	72.73	3	1244	53.8	5.25	119.0	115.0
PbAc	75	86.17	3	1255	65.2	3.55	103.0	122.0
PbAc	225	261.26	4	1222	110.4	9.3	293.0	201.0
PbAc	225	271.00	4	1225	109.2	9.1	227.0	249.0
PbAc	225	254.18	4	1226	103.8	12.05	360.0	317.0
PbAc	225	215.60	4	1241	127.9	4.35	228.0	264.0
PbAc	225	193.84	4	1249	109.4	3.75	606.0 b	333.0 b
Galena	75	82.08	5	1201	7.5	1.6 b	10.0	10.0
Galena	75	84.49	5	1233	7.5	0.5	10.0	644.0 a
Galena	75	87.39	5	1250	8.7	0.5	24.0	10.0
Galena	75	68.28	5	1251	7.5	0.5	10.0	10.0
Galena	75	70.57	5	1253	10.2	0.5	10.0	10.0
Galena	225	252.65	6	1203	10.8	0.5	10.0	10.0
Galena	225	252.87	6	1209	7.5	1.15	10.0	10.0
Galena	225	220.06	6	1214	9.3	0.5	10.0	10.0
Galena	225	232.36	6	1231	8.6	0.5	10.0	10.0
Galena	225	210.95	6	1247	7.5	0.5	10.0	10.0
Galena	675	804.36	7	1218	14.2	1.05	32.0	10.0
Galena	675	714.93	7	1229	12.1	0.5	10.0	10.0
Galena	675	627.11	7	1235	7.5	0.5	35.0	20.0
Galena	675	776.25	7	1237	8.3	0.5	10.0	22.0
Galena	675	641.98	7	1254	13.3	1.3	22.0	10.0

a *a priori* outlier determinations
b Outside 95% Prediction Intervals

TABLE A-9 Best Curve Fit Parameters

BLOOD

PbAc Curve -	Exp
a	6.8
b	
c	129
d	0.0066
R2	0.949

Galena Curve -	Exp
a	6.8
b	
c	129
d	5.01E-05
R2	0.042

BONE

PbAc Curve -	Linear
a	0.62
b	0.0312
c	
d	
R2	0.774

Galena Curve -	Linear
a	0.62
b	0.00018
c	
d	
R2	0.017

LIVER

PbAc Curve -	Linear
a	14.7
b	1.049
c	
d	
R2	0.903

Galena Curve -	Linear
a	14.7
b	0.0063
c	
d	
R2	0.00

KIDNEY

PbAc Curve -	Linear
a	10.4
b	1.021
c	
d	
R2	0.889

Galena Curve -	Linear
a	10.4
b	0.0047
c	
d	
R2	0.194

Equations Used

EXP	Y=a+c*(1-exp(-d*dose))
LIN	Y=a+b*dose

TABLE A-10 Relative Bioavailability of Lead in Test Material

Endpoint	Test Material Galena
Blood	0.01
Kidney	0.00
Liver	0.01
Bone	0.01

Definitions

Plausible Range:	RBA(Blood) to mean RBA for Tissues
Preferred Range:	RBA(Blood) to (RBA(Blood) + RBA(Tissues))/2
Suggested Point Est:	1/2(RBA(Blood) + (RBA(Blood)+RBA(Tissues))/2)

Relative Bioavailability

	Galena	
Plausible Range	0.01	0.01
Preferred Range	0.01	0.01
Point Estimate	0.01	

Absolute Bioavailability

	Galena	
Plausible Range	0%	0%
Preferred Range	0%	0%
Point Estimate	0%	

TABLE A-11 INTRALABORATORY DUPLICATES

RPD = Relative Percent Difference
RPD = 100*[Orig-Dup]/((Orig+Dup)/2

* Non detects evaluated at 1/2 DL

Pig Number	group	material administered	dosage	day	matrix	Duplicate Value*	Original Value*	Average	RPD	Avg RPD	
1243	3	PbAc	75	-4	BLOOD	0.5	0.5	0.5	0%		
1251	5	Galena	75	-4	BLOOD	0.5	0.5	0.5	0%		
1209	6	Galena	225	-4	BLOOD	0.5	0.5	0.5	0%		
1236	1	Control	0	0	BLOOD	0.5	0.5	0.5	0%		
1208	2	PbAc	25	0	BLOOD	0.5	0.5	0.5	0%		
1217	2	PbAc	25	0	BLOOD	0.5	0.5	0.5	0%		
1222	4	PbAc	225	1	BLOOD	3.1	1.9	2.5	-48%		
1203	6	Galena	225	1	BLOOD	0.5	0.5	0.5	0%		
1252	8	Palmerton Loc2	25	1	BLOOD	0.5	0.5	0.5	0%		
1212	9	Palmerton Loc2	75	2	BLOOD	0.5	0.5	0.5	0%		
1221	10	Palmerton Loc2	225	2	BLOOD	4.2	4	4.1	-5%		
1246	10	Palmerton Loc2	225	2	BLOOD	3.3	2.2	2.75	-40%		
1233	5	Galena	75	3	BLOOD	0.5	0.5	0.5	0%		
1216	10	Palmerton Loc2	225	3	BLOOD	6.9	5.8	6.35	-17%		
1242	11	Oregon Gulch	225	3	BLOOD	0.5	0.5	0.5	0%		
1226	4	PbAc	225	5	BLOOD	5.2	6.2	5.7	18%		
1247	6	Galena	225	5	BLOOD	0.5	0.5	0.5	0%		
1229	7	Galena	675	5	BLOOD	0.5	0.5	0.5	0%		
1236	1	Control	0	7	BLOOD	0.5	1.1	0.8	75%		
1215	2	PbAc	25	7	BLOOD	2.6	2.7	2.65	4%		
1250	5	Galena	75	7	BLOOD	0.5	1.1	0.8	75%		
1241	4	PbAc	225	9	BLOOD	10	9	9.5	-11%		
1233	5	Galena	75	9	BLOOD	0.5	0.5	0.5	0%		
1203	6	Galena	225	9	BLOOD	0.5	0.5	0.5	0%		
1236	1	Control	0	12	BLOOD	0.5	0.5	0.5	0%		
1225	4	PbAc	225	12	BLOOD	8.7	10.4	9.55	18%		
1221	10	Palmerton Loc2	225	12	BLOOD	7.6	6.6	7.1	-14%		
1241	4	PbAc	225	15	BLOOD	10.8	9.4	10.1	-14%		
1204	11	Oregon Gulch	225	15	BLOOD	1.8	0.5	1.15	-113%		
1224	11	Oregon Gulch	225	15	BLOOD	2.3	1.9	2.1	-19%	-7%	BLOOD
1241	4	PbAc	225	15	FEMUR	15.05	4.35	9.7	-110%		
1239	10	Palmerton Loc2	225	15	FEMUR	6.65	5.8	6.225	-14%		
1204	11	Oregon Gulch	225	15	FEMUR	1.4	1.1	1.25	-24%	-49%	FEMUR
1227	3	PbAc	75	15	KIDNEY	93	107	100	14%		
1235	7	Galena	675	15	KIDNEY	10	20	15	67%		
1246	10	Palmerton Loc2	225	15	KIDNEY	170	225	197.5	28%	36%	KIDNEY
1251	5	Galena	75	15	LIVER	10	10	10	0%		
1207	8	Palmerton Loc2	25	15	LIVER	27	28	27.5	4%	2%	LIVER

TABLE A-12 CDC STANDARDS

Sample ID	Day	Q	Measured* Low Std	Measured* Med Std	Measured* High Std	Nominal Low Std	Nominal Med Std	Nominal High Std
12.1	-4	<	1			1.7	4.8	14.9
12.1	0		1			1.7	4.8	14.9
12.1	1	<	1			1.7	4.8	14.9
12.1	3		1.8			1.7	4.8	14.9
12.1	5		1.6			1.7	4.8	14.9
12.1	12		1.7			1.7	4.8	14.9
12.2	-4			4.6		1.7	4.8	14.9
12.2	1			4.8		1.7	4.8	14.9
12.2	2			3.9		1.7	4.8	14.9
12.2	3			4.9		1.7	4.8	14.9
12.2	7			4.4		1.7	4.8	14.9
12.2	9			5.3		1.7	4.8	14.9
12.2	15			4		1.7	4.8	14.9
12.3	0				16.5	1.7	4.8	14.9
12.3	2				16.3	1.7	4.8	14.9
12.3	5				15.1	1.7	4.8	14.9
12.3	7				15.4	1.7	4.8	14.9
12.3	9				17.4	1.7	4.8	14.9
12.3	12				11.4	1.7	4.8	14.9
12.3	15				16.1	1.7	4.8	14.9
Averages			1.35	4.56	15.46			

* Non-detects evaluated at the detection limit

TABLE A-13 INTERLABORATORY COMPARISON

Tag Number	Pig Number	Group	Material Administered	Dosage	Qualifier			Result			
					CDC	EPA		CDC	EPA	Average	RPD
8-912-0120	1204	11	Oregon Gulch	225	<	<		0.6	1	0.8	50
8-912-0121	1207	8	Palmerton Loc 2	25	<	<		0.6	1	0.8	50
8-912-0122	1225	4	PbAc	225	<	<		0.6	1	0.8	50
8-912-0177	1253	5	Galena	75	<	<		0.6	1	0.8	50
8-912-0178	1232	9	Palmerton Loc 2	75	<	<		0.6	1	0.8	50
8-912-0179	21217	2	PbAc	25	<	<		0.6	1	0.8	50
8-912-0234	1210	9	Palmerton Loc 2	75	<	<		0.6	1	0.8	50
8-912-0235	1229	7	Galena	675	<	<		0.6	1	0.8	50
8-912-0236	1238	11	Oregon Gulch	225	<	<		0.6	1	0.8	50
8-912-0291	1245	8	Palmerton Loc 2	25	<	<		0.6	1	0.8	50
8-912-0292	1204	11	Oregon Gulch	225	<	<		0.6	1	0.8	50
8-912-0293	1221	10	Palmerton Loc 2	225				2.4	4	3.2	50
8-912-0348	1241	4	PbAc	225				8.2	7.8	8	-5
8-912-0349	1213	2	PbAc	25				1	2.4	1.7	82
8-912-0350	12.1	--	--	--	<			0.6	1.8	1.2	100
8-912-0405	1238	11	Oregon Gulch	225	<			0.6	1.6	1.1	91
8-912-0406	1240	3	PbAc	75				4.3	4.9	4.6	13
8-912-0407	1255	3	PbAc	75				3.5	4.9	4.2	33
8-912-0462	1251	5	Galena	75	<	<		0.6	1	0.8	50
8-912-0463	1223	8	Palmerton Loc 2	25	<	<		0.6	1	0.8	50
8-912-0464	1238	11	Oregon Gulch	225	<			0.6	1.6	1.1	91
8-912-0519	1204	11	Oregon Gulch	225	<			0.6	1.3	0.95	74
8-912-0520	1226	4	PbAc	225				7.9	9.1	8.5	14
8-912-0521	1242	11	Oregon Gulch	225	<			0.6	1.3	0.95	74
8-912-0576	21236	1	Control	0	<	<		0.6	1	0.8	50
8-912-0577	1203	6	Galena	225	<			0.6	1.2	0.9	67
8-912-0578	1225	4	PbAc	225				9.3	10.4	9.85	11
8-912-0633	1241	4	PbAc	225				9.8	9.4	9.6	-4
8-912-0634	1225	4	PbAc	225				8	8.4	8.2	5
8-912-0635	1247	6	Galena	225	<	<		0.6	1	0.8	50

FIGURE A-1 PbAc Groups by Day
Raw Data

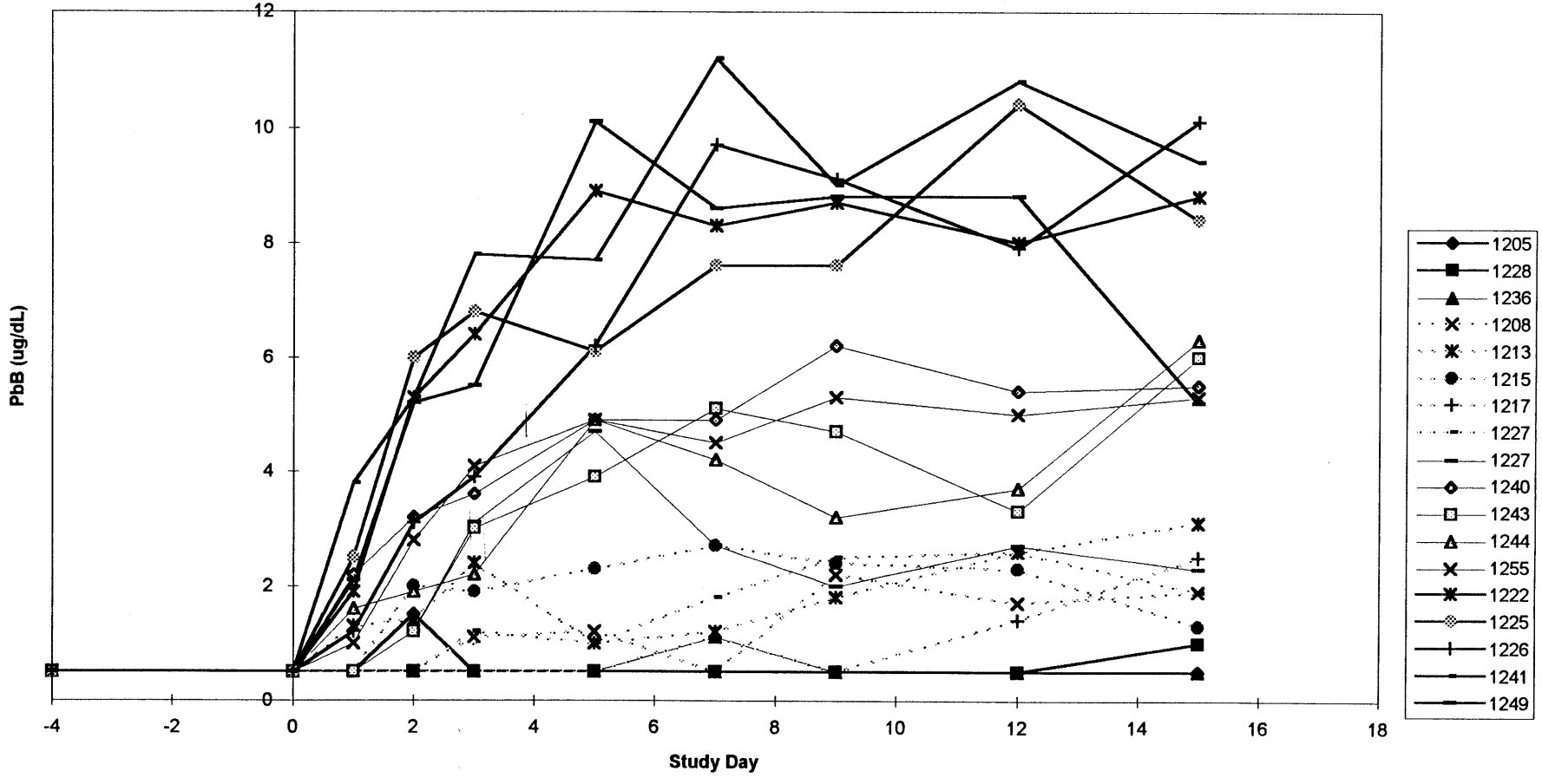


FIGURE A-2 Galena Groups by Day
Raw Data

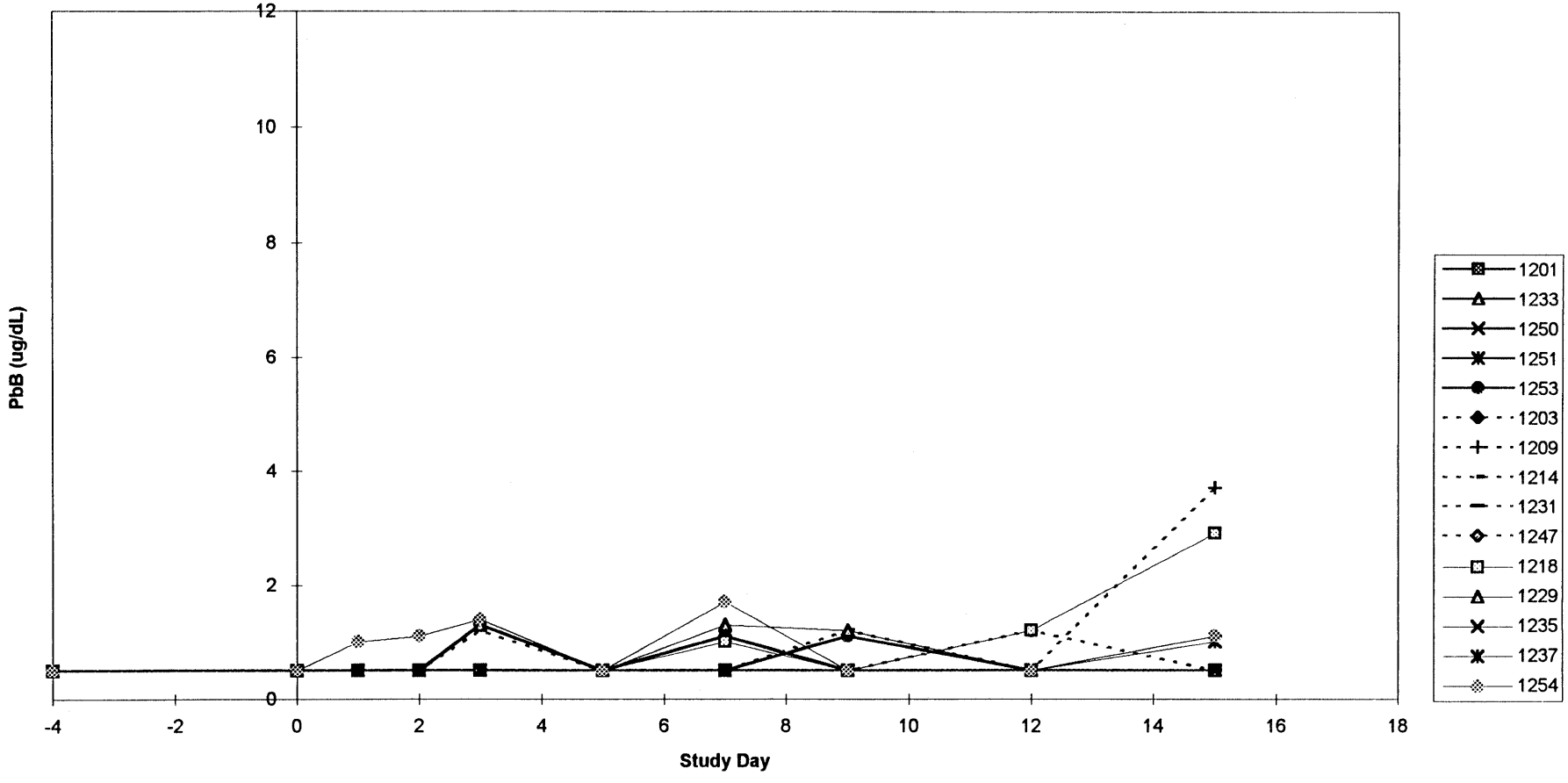


FIGURE A-3

This page left intentionally blank

FIGURE A-4 Group Mean PbB By Day
Raw Data

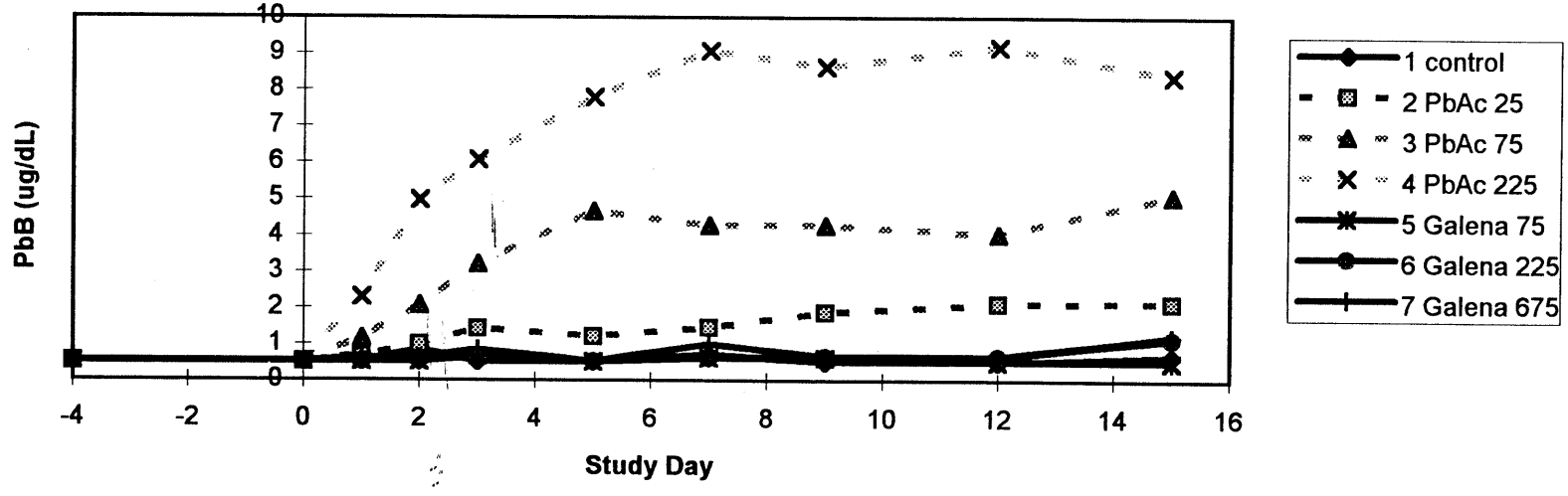
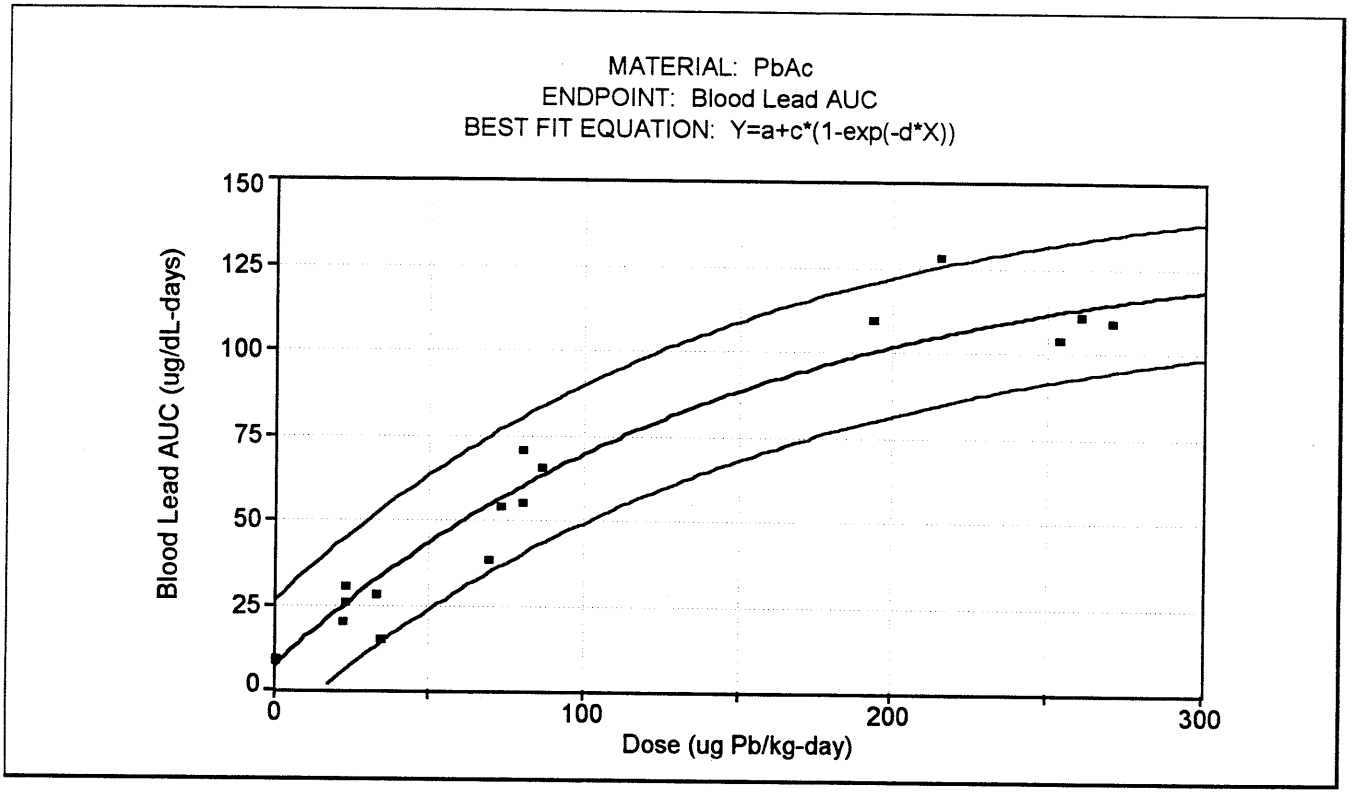


FIGURE A-5 BEST FIT CURVE WITH 95% PREDICTION INTERVALS*

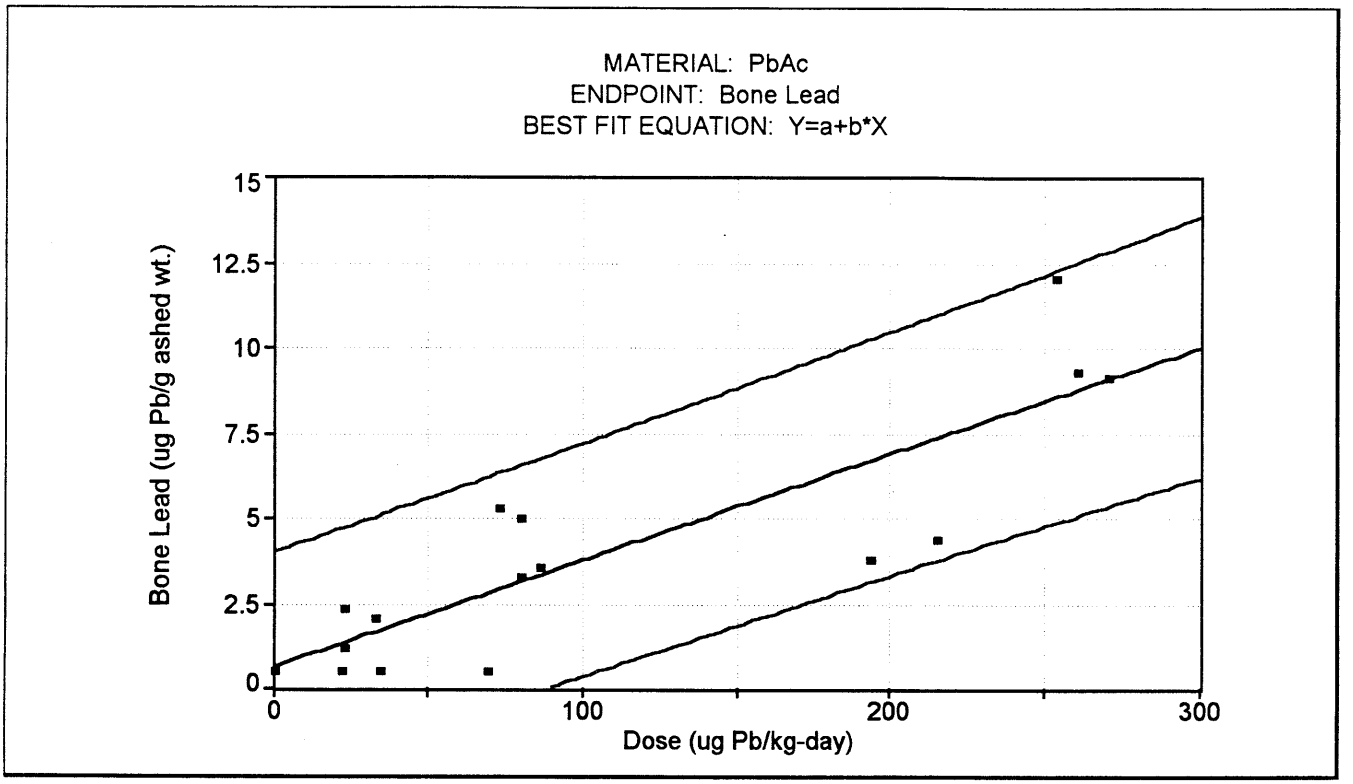


Parameters	Value	Std. Error	95% Confidence Limits	
a	6.8	fixed value	--	--
c	129	fixed value	--	--
d	0.0066	0.0005	0.0056	0.0076

Adj R^2	0.949

Generated using Table Curve 2D v. 3.0. Outliers represented by "+".

FIGURE A-6 BEST FIT CURVE WITH 95% PREDICTION INTERVALS*

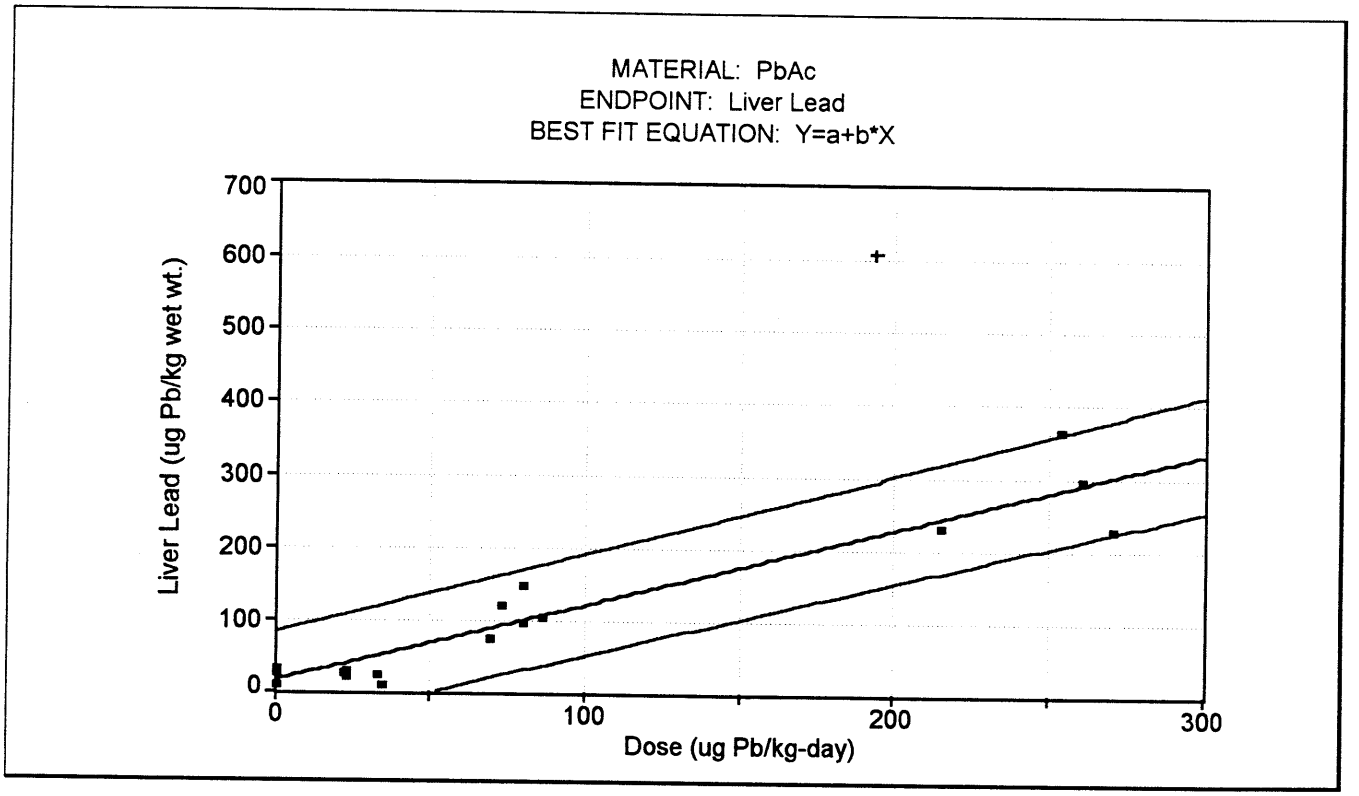


Parameters	Value	Std. Error	95% Confidence Limits	
a	0.62	fixed value	--	--
b	0.031	0.0029	0.025	0.037

Adj R^2	0.774

Generated using Table Curve 2D v. 3.0. Outliers represented by "+".

FIGURE A-7 BEST FIT CURVE WITH 95% PREDICTION INTERVALS*

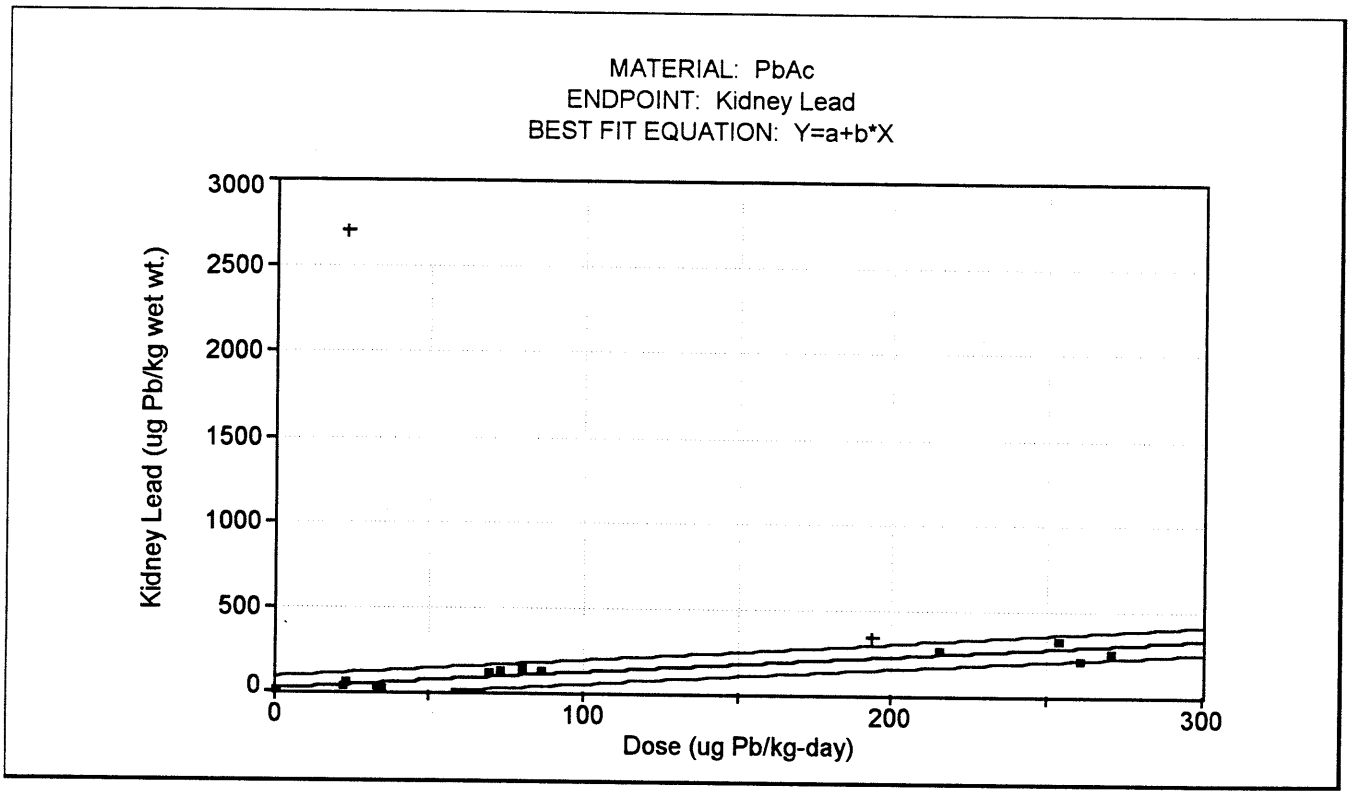


Parameters	Value	Std. Error	95% Confidence Limits	
a	14.7	fixed value	–	–
b	1.049	0.063	0.914	1.183

Adj R^2	0.903

Generated using Table Curve 2D v. 3.0. Outliers represented by "+".

FIGURE A-8 BEST FIT CURVE WITH 95% PREDICTION INTERVALS*

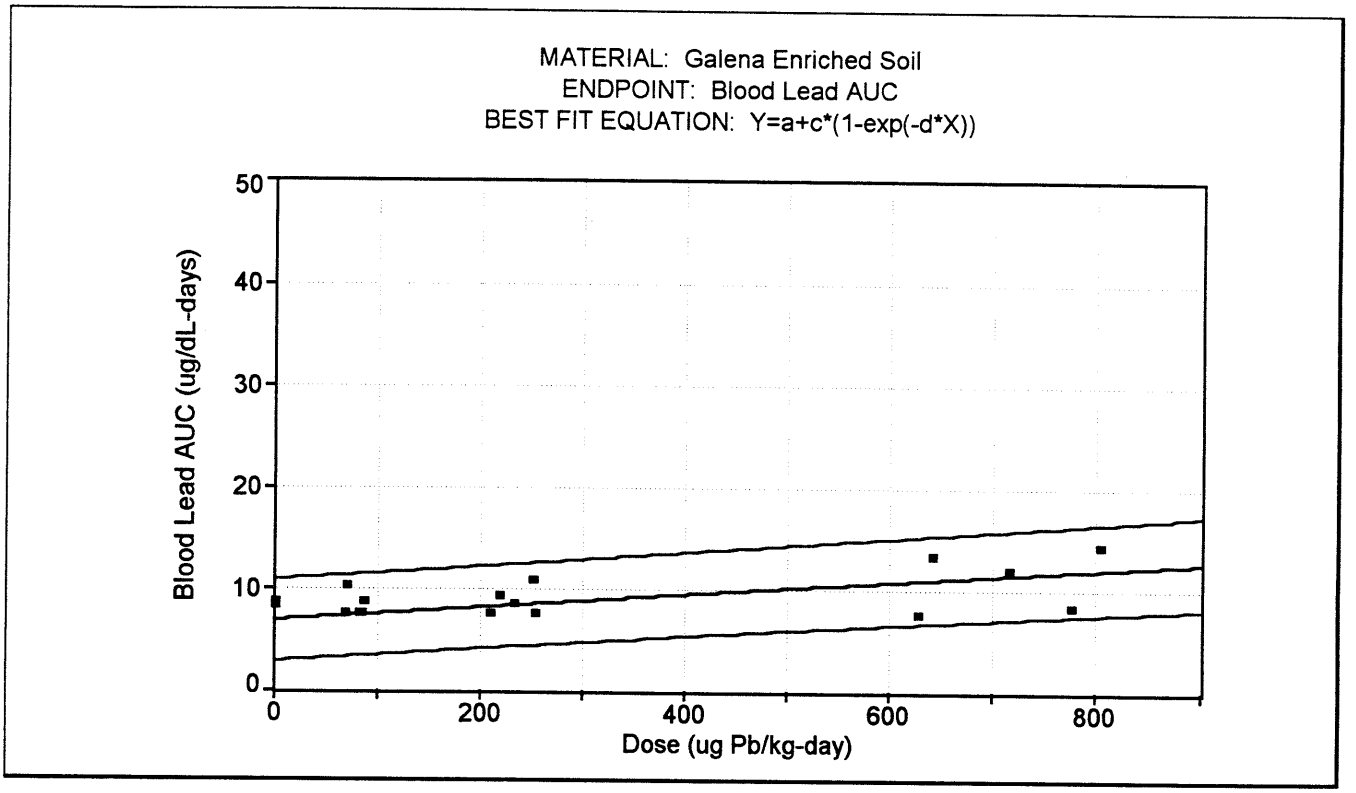


Parameters	Value	Std. Error	95% Confidence Limits	
a	10.4	fixed value	--	--
b	1.021	0.064	0.886	1.157

Adj R^2	0.889

Generated using Table Curve 2D v. 3.0. Outliers represented by "+".

FIGURE A-9 BEST FIT CURVE WITH 95% PREDICTION INTERVALS*

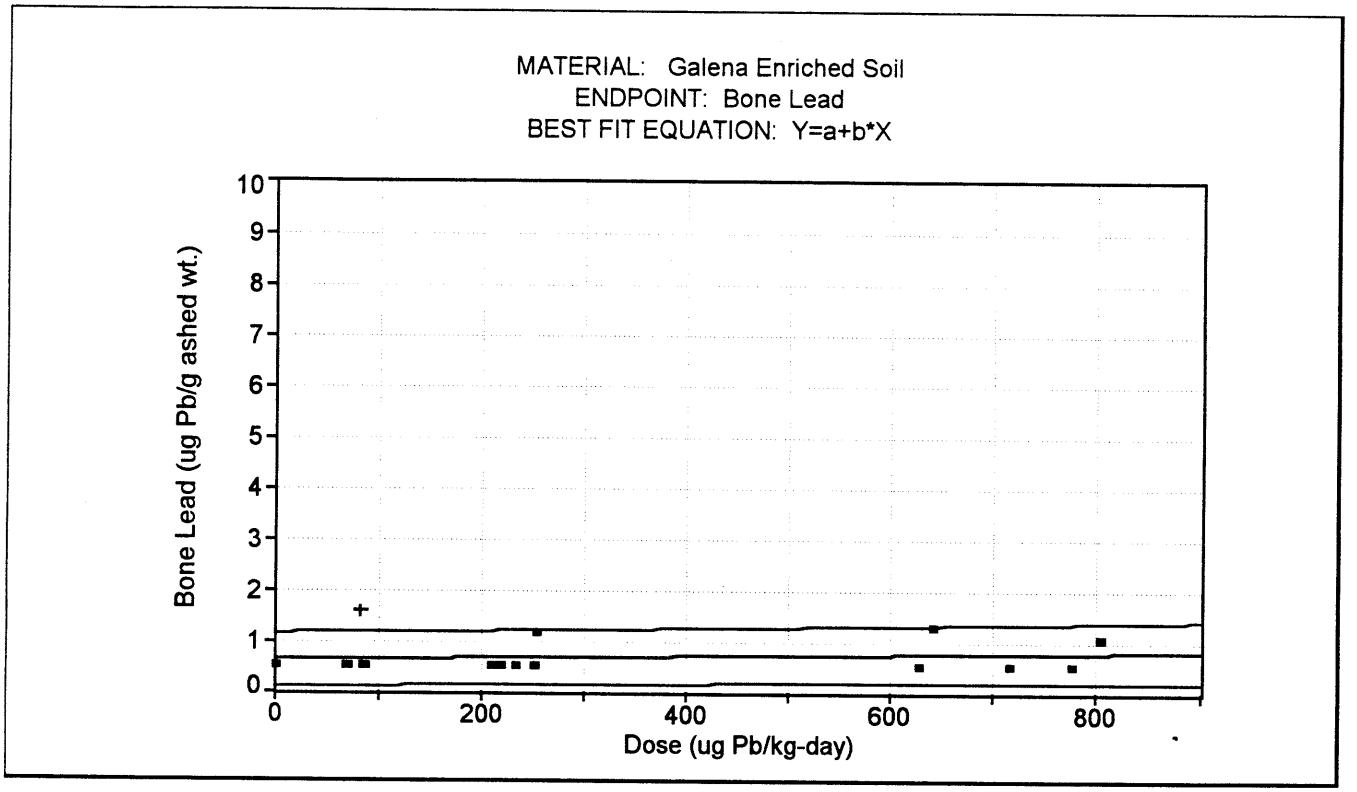


Parameters	Value	Std. Error	95% Confidence Limits	
a	6.8	fixed value	--	--
c	129	fixed value	--	--
d	5E-05	9.4E-06	3E-05	7E-05

Adj R^2	0.042

Generated using Table Curve 2D v. 3.0. Outliers represented by "+".

FIGURE A-10 BEST FIT CURVE WITH 95% PREDICTION INTERVALS*

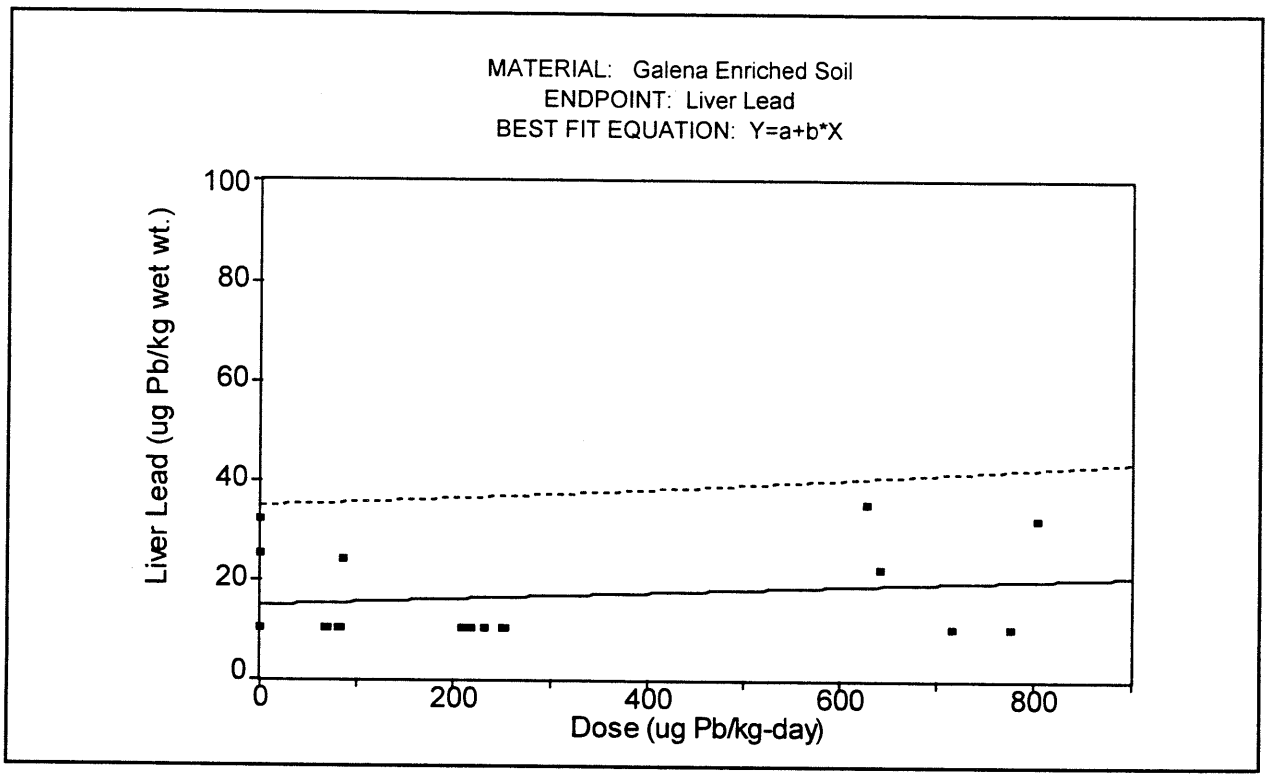


Parameters	Value	Std. Error	95% Confidence Limits	
a	0.62	fixed value	–	–
b	0.0002	0.00015	-0.0001	0.0005

Adj R^2	0.017

Generated using Table Curve 2D v. 3.0. Outliers represented by "+".

FIGURE A-11 BEST FIT CURVE WITH 95% PREDICTION INTERVALS*

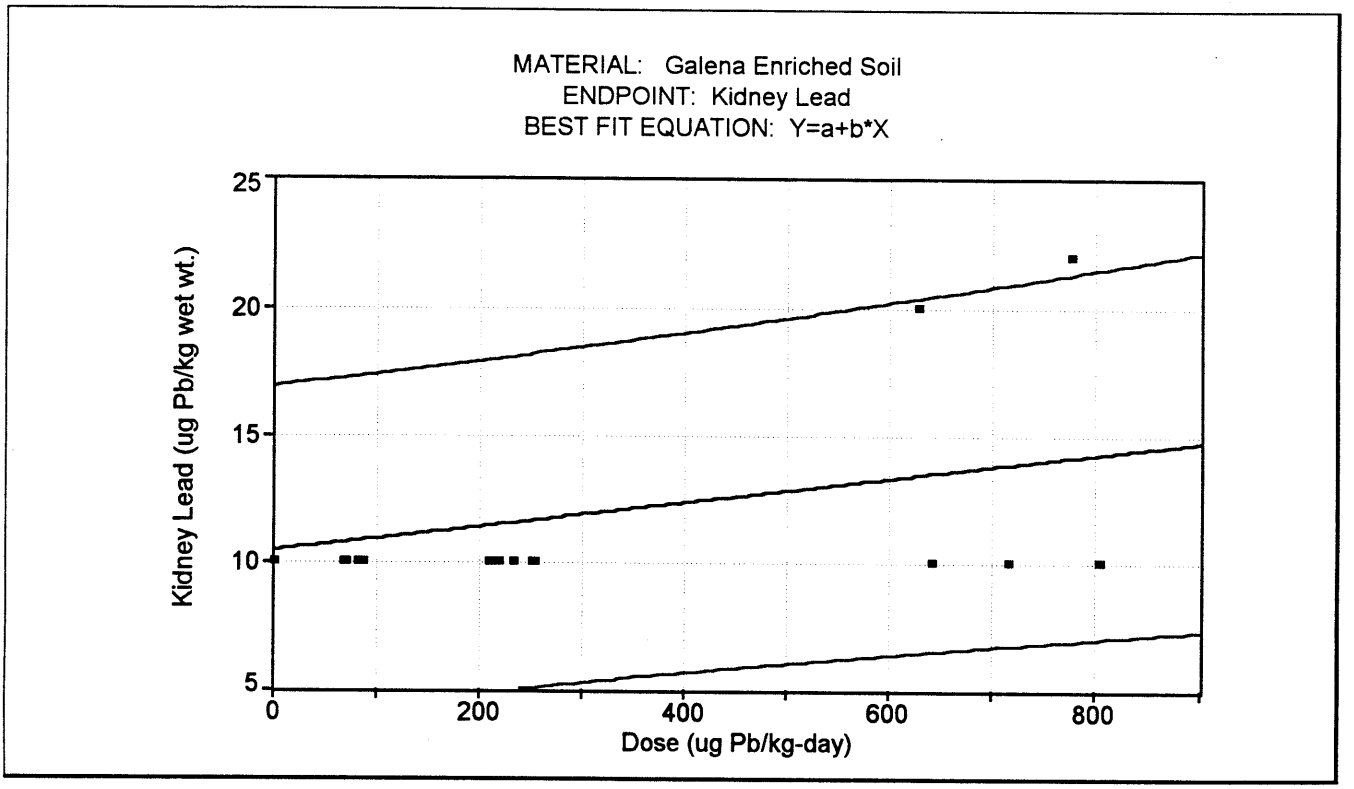


Parameters	Value	Std. Error	95% Confidence Limits	
a	14.7	fixed value	--	--
b	0.0063	0.006	-0.006	0.019

Adj R^2	0.00

Generated using Table Curve 2D v. 3.0. Outliers represented by "+".

FIGURE A-12 BEST FIT CURVE WITH 95% PREDICTION INTERVALS*



Parameters	Value	Std. Error	95% Confidence Limits	
a	10.4	fixed value	--	--
b	0.0047	0.0019	0.0007	0.0088

Adj R^2	0.194

Generated using Table Curve 2D v. 3.0. Outliers represented by "+".